PRODUCT ENGINEERING

VOLUME 7 NUMBER 10

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November Number

The report of our annual survey of activities and trends in product design has been a feature of our November number. This year the report will be greatly condensed, a few pages of charts and tables will tell the story.

Having told what designing engineers are doing and aiming to do, November *P.E.* will then tell what industry has done in the development of new alloys, nonmetallic materials, electric motors and devices, hydraulic units, machine parts and finishes. Here will be a symposium of progress that all of our readers will find of great reference value in bringing themselves up to date on the latest things obtainable.

Finally, having told about the new things, November *P.E.* will tell where they might be procured. This is the purpose of the comprehensive "Where-To-Buy" Directory, which will be the third feature of this triple value designers' reference issue.

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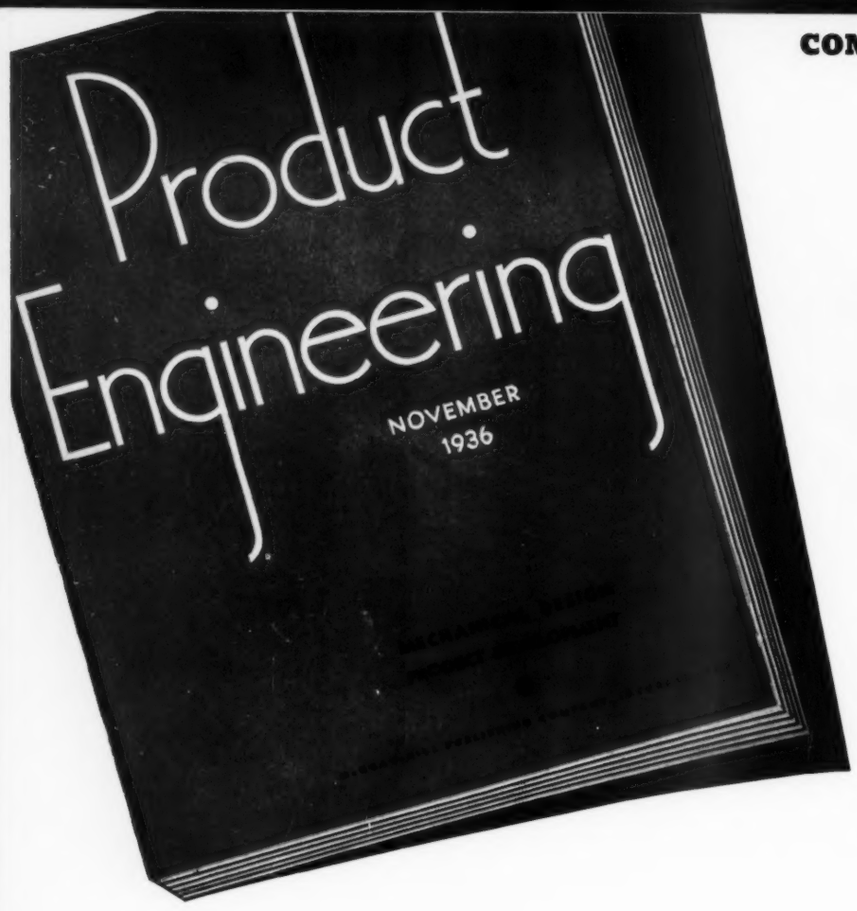
COMING NEXT MONTH...WATCH FOR IT!



A PRACTICAL REFERENCE ISSUE

for year 'round use

Now **PRODUCT ENGINEERING'S** famous November product development survey issue adds two new vital features that make it more practical, more usable, more valuable than ever before

Four STAR features

1 REPORT ON ACTIVITY. 5th Annual Report on Activity and Trends. How many design engineers are employed in product-development work this year as compared with last? Are other companies increasing their product-development work? Is your company keeping pace with other manufacturers? Find out by reading the first star feature in the November issue.

2 REPORT ON TRENDS. Here's the big news story of the year in the design-engineering world. What are the trends in modern design? How are other designers giving their products new sales appeal? Two of the many questions that will be answered for you by the second star feature.

plus

3 REVIEW OF 1936 DEVELOPMENTS. Here's a handy, easy-to-refer-to compilation of recently developed parts, materials and finishes. Technical data will be included and all similar items will be classified together. You will want to refer to this star feature time and time again when you design your next model.

plus

4 WHERE-TO-BUY DIRECTORY. At last, a complete classified directory especially prepared for design engineers! Divided into five sections: (1) materials, (2) electrical parts, (3) mechanical parts, (4) finishes, and (5) engineering department equipment. Each section will contain advertisements showing the features of the products made by the leading manufacturers listed in that group. A real star feature that will help you find added sales features for your new models.

Here's a real reference issue you'll want to keep and use for months to come. It should be one of the most thumbed-over books in your working library. Watch for it!

NOVEMBER PRODUCT ENGINEERING

Watch for it . . . Use it . . . keep it for reference throughout 1937

PRODUCT ENGINEERING

GEORGE F. NORDENHOLT, *Editor*

MCGRAW-HILL PUBLISHING CO., INC. OCTOBER 1936 VOLUME SEVEN, NUMBER TEN

For the Company's Profit At the Company's Expense

TECHNICAL meetings, industrial exhibits, conventions and symposiums follow each other in rapid succession. Engineers from all over the country gather in the convention city, wherever it may be, to swap the latest ideas, suggest new problems to be investigated, listen to papers on new technical developments and perhaps enter into the discussions of debatable points. New friendships are made; old ones are revived. As to the legitimate expenses, who pays them? Who should foot the bill, the engineer or his company?

Most of the leading companies pay the legitimate traveling expenses of their engineers when attending conventions or technical meetings. We know of no big company that does not, although a few seem to be "Scotchy" about the number of men they send to the meetings. Among the medium and smaller size companies there seem to be too many that do not send any of their engineers at the company's expense. The number of such companies seems to be growing fewer. But there are still too many that will send men to shows where the company is exhibiting but not to technical meetings.

Assuming that a qualified engineer attends a technical meeting and gets something out of it, who reaps the benefit? The greatest benefit goes to industry because everybody profits from open and frank discussions of technology. Thus there is bound to be an indirect profit to the company that sends representatives to the meeting. And if the representatives attend in the proper spirit, the company will receive directly the benefits of their experiences.

It seems to be the attitude of some companies that in view of the fact that the engineer who attends a meeting profits thereby, the individual should pay his own expenses. Also, there is the feeling that many go to conventions just for a good time. It is true that the individual will usually benefit and improve his chances for advancement, either in his own company or through the opportunity of a better job with a competitor. But in either case, advancement can take place only after the man has demonstrated his increased value, that is, after the company has profited as a result of the more valuable work the man has accomplished.

AS FOR the "parties" that are a part of conventions, it is true that some individuals do not confine them or the effects thereof to the "off hours." The solution to this problem is for the company not to send representatives who fail to conduct themselves properly and waste their time.

The old philosophy that an employee should not be given the opportunity to become more valuable because he will have to be paid more has been thrown in the discard by all intelligently managed companies. No company can be better than the average of its personnel. That is why such companies send their engineers to technical meetings and pay the traveling expenses. And that is why all companies should do it.

Eighteenth Annual

National Metal Show

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Sponsored by the American Society for Metals

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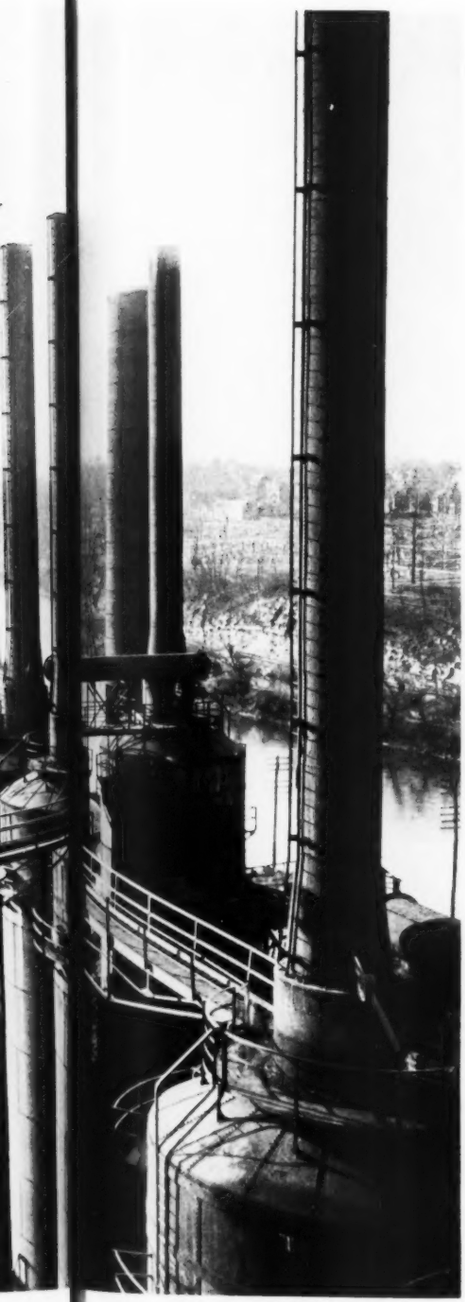
Cleveland
Public Auditorium
Cleveland, Ohio



Bethlehem Steel Company

October

19 to 23

Inclusive

TO BE SEEN AT THE SHOW

Terse descriptions of the exhibits, classified under the headings of (1) metals and alloys, (2) furnaces, (3) control devices and instruments, (4) welding equipment, (5) plant and shop equipment, (6) laboratory testing machines and equipment, (7) supplies and miscellaneous products.

Metals and Alloys

Acme Steel Company. Besides Acme Superstrip steel, hot and cold rolled, there will be shown stainless strip steel and Colorstrip steel. This latter will be the feature of this exhibit. Practically all colors and shades can be reproduced in this cold-rolled strip steel, the color being obtained by lacquering. (Booth M-9)

Allegheny Steel Company. Many applications of Allegheny Metal and other grades of Allegheny time tested stainless steels. A number of new fabricated items which have been marketed during the past year and various samples of commercial forms such as sheets, bars, plates, strip, tubing, wire, rivets, etc. (Booth C-22)

Edgar Allen Steel Company, Inc. Exhibiting a line of special tool steels. Exhibiting jointly in this booth will be A. Milne & Company, tool steel specialties and hollow and solid rock drill steel. (Booth D-22)

Aluminum Company of America. An exhibit displaying new developments of the aluminum industry with numerous samples of new types of aluminum sections, impact extruded parts, and for the first time on exhibit, examples of hot-pressed aluminum parts. (Booth I-23)

American Brass Company. Exhibiting a selection of high-strength copper alloys such as Everdur metals, beryllium copper, Tempaloy, Tobin bronze and Phosphor bronze in commercial and farbicated form. Feature section of the exhibit will be a welding booth demonstrating both oxy-acetylene and electric arc welding methods with bronze rods and also demonstrating the long arc high voltage welding of copper. (Booth C-21)

American Machine & Metals Mfg. Company. (Booth B-19)

American Rolling Mills Company. Some of the most intricate stainless steel etchings ever produced will form part of a new and colorful background for the exhibit, which will depict scenes showing various operations in the manufacture of iron and steel. On display will be the newest applications of porcelain enamel, stainless and high-tensile steels. (Booth L-59)

American Sheet & Tin Plate Company. (Booth C-15)

Ampco Metal, Inc. A representative display of rough and finished Ampco metal sand and centrifugal castings, and forgings, together with an exhibit of stainless steel parts and parts of other alloys which have been formed or drawn over Ampco metal dies. In addition, there will be parts made of Ampco metal for machinery, various acid resistance castings, heavy-duty bushings and bearings, general machine tool parts, and a display of photographs and mircophotographs dealing with applications of the metal and its characteristics. (Booth A-19)

●

Bliss & Laughlin, Inc. Exhibiting motion picture showing the various operations necessary in the production of quality cold finished bar steels, a display of fabricated parts as cut from such bar steel. (Booth F-20)

●

Calorizing Company. Exhibiting centrifugally cast tubes, a new type of annealing box, furnace rollers, chain, etc.

Carboloy Company, Inc. (Booth A-20)

Climax Molybdenum Company. Exhibiting a series of panels exemplifying the application of molybdenum steels and irons. (Booth F-3)

Colmonoy Company. (Booth N-46)

Columbia Tool Steel Company. Tools and specimens of Clarite high speed, Vanite high speed, Maxite super high speed, Superdie high carbon-high chromium. Oildie non-shrinking, Exl-die oil hardening, Buster punch and chisel, Special, Extra Vanadium, Extra and Standard tool steel. (Booth H-32)

Cyclops Steel Company. (Booth G-32)

●

Dow Chemical Company. On display will be a wide variety of Dowmetal sand castings, diecastings, forgings and extruded parts, as well as assembled articles in which Dowmetal parts are being used as standard equipment. (Booth C-27)

Driver-Harris Company. Exhibiting heat and corrosion resisting alloys such as "Nichrome," Chromax, Cimet; in the form of castings, bars, stirp, carburizing containers, sheet containers, enameling racks, normalizing shafts, dipping baskets, lead pots, and diamond dies. (Booth G-21)

Electro Metallurgical Company. Charts, specimens and actual illustrations of industrial uses will be on display to show the effects of nitrogen and columbium in chromium steel and in chromium-nickel steel, and numerous applications of alloy cast irons in the automotive field. It will also be shown how alloy-bearing briquets are used in the manufacture of alloy cast irons. Among the types of alloy steels being featured will be the new columbium-bearing 2 to 3 per cent chromium steel. (Booth O-30)

●

Firth-Sterling Steel Company. In operation will be one of their new Braze-Rite furnaces especially designed to improve the brazing of carbide tips to shanks. Their exhibit will also show cross-sections and specimens of their winged ingots used in makng fine tool steels, specimens of tool steel and of stainless steel made from their products. (Booth D-32)

Fulton Foundry & Machine Company, Inc. Exhibiting mechanite metal, a special high strength grey iron made by patented Meehanite process. Many samples, and specific castings made of this metal showing the range of applications and the structure of the metal. Photomicrographs and other interesting data. (Booth O-33)

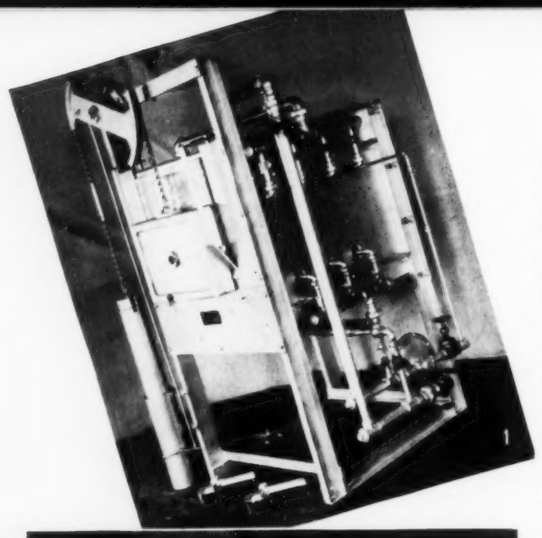
●

Great Lakes Steel Corporation. Exhibiting motion picture, showing manufacturing processes and also exhibit samples of products fabricated from their material. (Booth P-16)

General Alloys Company. Included in their exhibit will be Nickel-Chromium Alloys, Q-Alloys, carburizing and annealing containers, cyanide and lead pots, furnace hearths, roller rails, heat and acid resisting chain, cyanide dipping baskets, recuperators, miscellaneous furnace parts, parts for every type heat-treating furnace; carburizing, annealing, normalizing, hardening, tempering, forging, spheroidizing, tubes and retorts; corrosion and abrasion-resisting castings. (Booth P-8)

Hamilton Steel Company. A complete line of tool steels will be on display. (Booth P-23)

Handy & Harman. A feature of the display will be low temperature brazing alloys and silver solders. Also shown will be various silver clad metals for corrosion resisting containers and equipment as well as electrical contact metals.



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Brazing with silver alloys will be demonstrated, including both oxy-acetylene brazing of ferrous and non-ferrous metals, and electrical resistance brazing and dip-brazing. Samples of various types of work will be exhibited. (Booth D-27)

Haynes Stellite Company. Exhibiting (in operation): A demonstration of a Haynes Stellite J-Metal tool cutting a steel billet, while the tool is continually kept at a red heat by means of an oxy-acetylene flame. Also other metal cutting tools of Haynes Stellite J-Metal, including milling cutter blades, welded-tip tools, solid tool bits and a number of special tools. Together with these will be shown castings of solid Haynes Stellite, and various parts showing the application of hard-facing with Haynes Stellite. In the latter classification will be shown Haynes Stellited steam valves for high-temperature, high-pressure steam service, aircraft and automotive valves and valve seat inserts and numerous other hard-faced parts. Various corrosion-resistant castings of Hastelloy, the acid-resistant alloy, will also be exhibited. (Booth O-30)

●

International Nickel Company, Inc. Exhibiting 6 alloys of nickel both ferrous and non-ferrous. (Booth B-7)

C. O. Jelliff Mfg. Corporation. Apparatus in which Kanthal resistance wire, strip and ribbon are used for electric heating, and sample heating elements. Several small complete electric furnaces will be shown in operation. Use of Kanthal heating elements will be shown as applied to both laboratory and industrial electric furnaces, and a number of domestic heating devices will be shown in which Kanthal resistance wire is used. (Booth N-11)

Jones & Laughlin Steel Corporation. (Booth E-15)

●

La Salle Steel Company. (Booth N-50)

Michiana Products Corporation. Exhibiting a full line of heat-resistant and stainless steel castings, centrifugally cast rolls for roller bottom steel mill furnaces, centrifugally cast carburizing pots and centrifugally cast tubing. (Booth N-18)

Michigan Steel Casting Company. Exhibited for the first time will be centrifugally cast conveyor rolls, the construction of these rolls consisting of a centrifugally cast tube to which is flash welded tapered end casting, thus avoiding mechanical joints of any description. There will also be exhibited for the first time a newly developed pusher chain and an insulated blast furnace blowpipe. Other displays will include centrifugally cast carburizing and annealing containers, pipe and tubing and other centrifugally cast products, chain and belt conveyors and numerous other castings illustrating a wide field of application for heat and corrosion-resisting castings.

The Midvale Company. Exhibiting a hardened and ground roll—large size. (Booth B-14)

Molybdenum Corp. of America. Diorama effect exhibiting molybdenum and tungsten alloys. (Booth O-24)

Monarch Steel Corporation. (Booth M-55)

●

New Jersey Zinc Company. An extensive collection of zinc alloy die castings will be on display, this exhibit including many interesting die castings in the ascast form, as well as a great variety of completely machined and finished die castings illustrating the various types of finishes now available. Numerous complete assemblies such as electrical appliances, business machines, household equipment and similar products in which zinc alloy die castings are being utilized, will be shown. Complete information on the recently patented dicromate metal protective coating, known as the "Cronak" process will be available.

A feature of the exhibit will be a mechanical display illustrating with a series of striking photographs such operations as castings, trimmings, finishing and other steps and then finally revealing on an open stage, the actual completed parts. (Booth D-21)

●

Page Steel & Wire Division. (Booth C-23)

Republic Steel Corporation. (Booth E-6)

John A. Roebling's Sons Company. Wire rope and miscellaneous round and flat wire. (Booth O-12)

Rustless Iron & Steel Corporation. Exhibiting rustless or stainless ingots, billets, bars, rods and wire in various commercial forms, finished articles and machined parts fabricated from rustless or stainless bars, rods and wire. (Booth L-43)

Joseph T. Ryerson & Son, Inc. Exhibiting steel and allied products. (Booth I-22)

●

Stoody Company. Exhibiting hard-facing materials. (Booth N-8)

Timken Steel & Tube Company. An attractive array of the various types and analyses of steels produced by the company, with representative cross-section samples of both tubes and solid. Displays include several low-carbon, low-alloy steels, developed especially for high-temperature service such as in power plants and refining equipment. Complete high-temperature data secured in the Timken laboratories and at the University of Michigan on a wide range of carbon and alloy steels will be available. (Booth F-33)

Titanium Alloy Manufacturing Company. Exhibiting: Examples of titanium treated steels, cast iron, aluminum, etc. (Booth M-50)

●

United States Steel Corporation. Will present a rounded-out display of "Progress in Steel Making," their exhibit featuring alloy steels now being marketed under the new trade name "USS CARILLOY" together with the well-known USS high tensile steels and USS stainless steels. (Booth C-15)

Universal Steel Company. Exhibiting all types of high grade tool steels, stainless steels, and specialty steels. (Booth G-32)

●

Vanadium-Alloys Steel Company. Exhibiting in operation, tantalum carbide tipped tools, drawing dies, sizing dies, and the products fabricated by them. Photographs and reports of actual results with Vascoloy-Ramet tools and dies will be available. (Booth Q-28)

Vanadium Corporation of America. (Booth G-2)

Wheelock, Lovejoy & Company, Inc. Exhibiting examples of parts manufactured from Hy-Ten and S.A.E. alloy steels. (Booth H-21)

Youngstown Sheet & Tube Co. (Booth E-24)

1 ***American Gas Furnace Company will exhibit in operation this improved heat-treating furnace in the gas section***

2 ***Controlled atmosphere high-speed muffle furnace for heat-treating displayed by Surface Combustion Corporation in the gas section***

3 ***Type CS heater with discharge hopper removed, to be exhibited in operation by the American Car and Foundry Company. Electronic controls are used to make the heaters automatic in operation***

4 ***On exhibit for the first time and in operation will be this small Leeds & Northrup tool and die tempering furnace which embodies their Homo principle of uniform heating***

Furnaces

Aetna Gasses, Inc. (Booth N-46)

Ajax Electric Company. Exhibited for the first time will be their new Ajax-Hultgren salt bath furnace for cyaniding, hardening, annealing or tempering. Immersed electrode generates heat directly within the salt bath and an internal automatic stiring action is produced by a patented arrangement of the electrode which utilizes electro magnetic forces to produce positive circulation to insure temperature uniformity. (Booth B-2)

Ajax Electrothermic Corporation. On display will be a commercial high-frequency melting furnace. Numerous enlargements of photographs of high-frequency furnace installations and products of high-frequency furnaces will be shown. (Booth A-3)

American Electric Furnace Company. Exhibiting a complete photographic display of standard Juthe gas and "American" electric furnaces, including installations. (Booth I-4)

American Gas Association. This association retained a large unit of floor space in the main section and the individual exhibits of the member companies are grouped around this booth or lounge.

American Gas Furnace Company. Exhibited for the first time will be their new design of oven furnace, wherein burners are provided on top, bottom and both sides. Products of combustion must exit through the bottom vent. The greater part of the heat is provided by the top burners which fire under the arch. Bottom burners are used only to the extent necessary to maintain uniformity throughout the chamber in larger furnaces, especially those having a high heating chamber.

Other items exhibited will be a small rotary carburizing machine, a vertical bell type retort furnace for carburizing, nitriding, and annealing. Included will be a small demonstrating full muffle reciprocating heating machine for hardening in a controlled atmosphere, a high heat melter, an improved pot hardening furnace, an improved oven and tool room furnace, burners, blowpipes, flow meters, heat controllers and other accessories.

●

Burdett Mfg. Company. On display will be Burdett burner heads made in sizes from 2½ in. up to 12 in. diameter.

Continental Industrial Engineers, Inc. A working model of the Continental patented forced convection heat-treating system will be on exhibit. This will be made to scale and provided with a glass in one wall so that it will be possible to observe the effect of the circulating air currents. Another feature of the exhibit will be a fully automatic heat-treating unit which will mechanically transfer the articles being heat-treated from a pre-heat position into a salt bath, from the salt bath into the quench bath and then through subsequent operations, returning the articles back to the loading position.

●

Eclipse Fuel Engineering Company. Will exhibit heat-treating furnaces, recirculating heaters, industrial gas burners including tunnel type, pipe type and miscellaneous other types, gas injectors, safety gas valves, proportional mixers, temperature control valves, pressure blowers, pressed steel pots and metal melting furnaces.

Electric Furnace Company. A display of enlarged photographs of their latest developments in controlled atmosphere furnaces for bright annealing, copper brazing and scale-free heat-treating. There will also be exhibited various materials treated in these furnaces. (Booth L-21)

General Electric Company. In operation, will be a controlled-atmosphere mesh-belt brazing furnace which will make regular production runs on many types of intricate assemblies which will be electric-furnace brazed. In addition, there will be on display two sizes of portable motor generator welders, three welding transformers, a gasoline-driven portable welding generator, and different types and sizes of electrodes. All of the welding units will be in operation for demonstration purposes. (Booth E-23)

●

C. I. Hayes, Inc. Exhibiting "Certain Curtain" atmosphere controlled furnaces, for heat-treatment of high speed, carbon and alloy steel tools; high temperature conveyor type copper brazing furnace; a high-speed steel hardening furnace in operation with atmospheric control attachments, and instruments for recording the furnace atmosphere; also an external atmosphere generator. (Booth G-15)

Hevi-Duty Electric Company. In operation will be two electric furnaces with metallic resistors, a vertical retort carburizing furnace, and a complete line of laboratory furnaces. (Booth G-25)

Charles A. Hones, Inc. On dislpay will be oven furnaces, melting furnaces, immersion fired tanks, soldering furnaces and various industrial burners. A feature of the display will be the high temperature melting furnaces especially designed for applications necessitating quick, intense heat without the use of blowers or boosters.

Hoskins Manufacturing Company. A comprehensive display of Chromel heating element alloys. (Booth M-59)

●

C. M. Kemp Manufacturing Company. In operation will be an industrial carburetor for premixing air and gas, demonstration of submerged combustion equipment for pickling tanks. (Booth, Gas Section)

J. W. Kelley Company. Exhibiting (in operation): Heat treating products, industrial oils, special exhibit of grinding oil. (Booth H-16)

●

Leeds & Northrup Company. For the first time, they will display their new Homo furnace which is a smaller model designed for tool or die tempering and embodies their Homo principle of uniform heating. A dense load Homo furnace will also be in operation and temperature-exploration tests will be run at frequent intervals. There will also be displayed in operation a triple-control hump hardening furnace to demonstrate control of atmosphere, rate of heat-input and quench point. The company invites anyone to bring a sample test piece to the booth to have it hardened. As described under Instruments, this company will also have a complete display of their line of Micromax temperature instruments and controls. (Booth I-15)

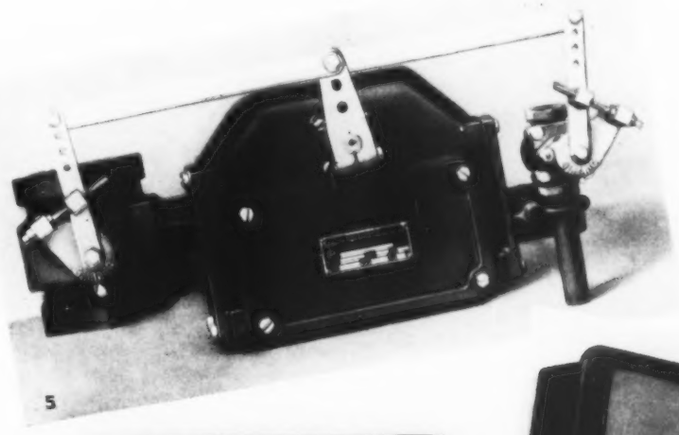
Lindberg Engineering Company. Exhibiting 2 Cyclone furnaces, gas and electric, in operation, a special demonstration of new Lindberg throttling valve and screw type pot furnace for lead, metals and alloys. (Booth L-33)

●

North American Mfg. Company. Will show a newly developed luminous flame burner in the American Gas Association booth at the show. This burner will be in operation in a scale model sheet furnace, arranged and constructed in such a way that the character of the flame produced by the burner can readily be observed.

In Booth M-45, the North American Mfg. Company will have on display a complete line of industrial gas burning equipment, including a luminous flame burner, pressure burners, tunnel burners, Venturi mixers, high-pressure inspirators, gas-air proportioning valves, oil-air proportioning valves, blowers and other smaller items of industrial gas burning equipment. (Gas Section and Booth M-45)

Philadelphia Drying Machinery Company. Will display photographs of new developments in furnaces for various heating applications, including annealing, carburizing, forging, hardening and the like. There will also be a complete dispay of oil burners ranging in size from ½ in. to 4 in. with oil capacities from 1/10 gal. per hr.,



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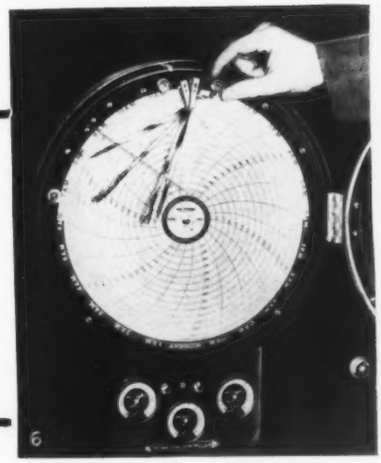

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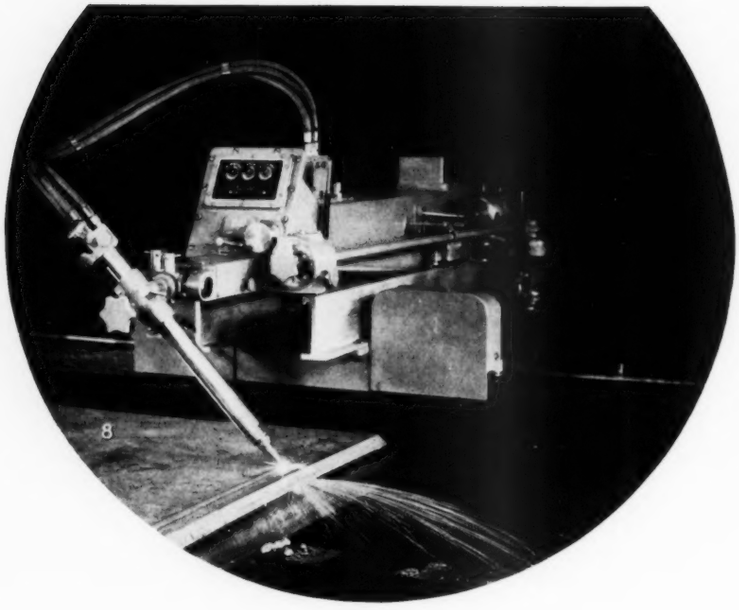
***5** Furnace temperature control units to be exhibited by Automatic Temperature Control Company. It regulates fuel rate in proportion to temperature deviation*

***6** Dual controller for regulating furnace temperatures, exhibited by the Brown Instrument Company, and air control thermometer*

***7** Stabilog potentiometer controller with deviation record for furnace temperature control, one of the exhibits of the Foxboro Company*



to 55 gal. per hr., and also three types of gas burners of the proportional mixing type, low-pressure velocity type and atmospheric type. (Booth M-46)

Salem Engineering Company. Photographs and motion pictures will show the operation of their direct-fired (oil or gaseous fuel) circular ingot heating furnace. (Booth M-10)

Selas Company. A new method of firing furnaces for heat treating processes in which close control of temperature and atmosphere is required, will be demonstrated in operation. Other exhibits will include new burner equipment, combustion controllers, flowmeters, bench furnaces, and various other industrial gas appliances.

Sentry Company. Will exhibit in operation their new Model "Y" electric high-speed steel hardening furnace. There will also be in operation the Sentry high temperature (2550 deg. F.) tube furnace for combustion analysis of stainless and other steels. (Booth O-25)

Surface Combustion Corporation. A small controlled atmosphere furnace in operation, and also an air heater for temperatures as high as 1200 deg. F. together with various display tables showing burner equipment and products heat-treated in Surface Combustion furnaces.

Feature exhibit will consist of two radiant tube heating elements mounted inside of brick-lined steel casing and equipped with three Pyrofax windows which will permit viewing the interior.

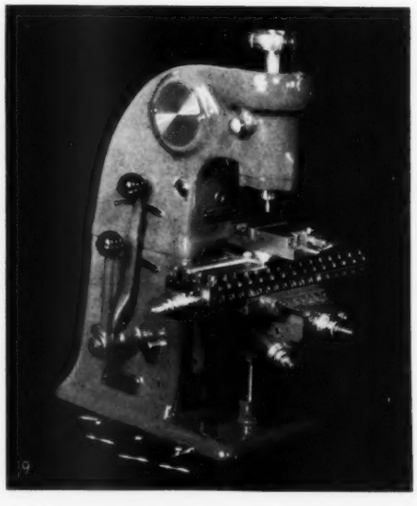
Control Devices and Instruments

Automatic Temperature Control Company, Inc. The feature of this exhibit will be a working demonstration of the Relatrol Control System which makes small and graduated changes in the fuel rates, exactly proportional to the temperature deviation from normal. This system incorporates various types of actuating relays suitable for conditions of constant loading or with either manual or automatic provision for variable loading. It may also be made for the remote positioning of valves or dampers by incremental steps which follow exactly the movements of the actuating switch. In addition, there will be a working demonstration of the ATC Balancer, various two and three-position control mechanisms, and an exhibit of current input controllers for electric furnaces with both manual and automatic adjustment, dial, cam and reset timers, and an exhibit of control valves for air, gas, water, oil and steam. (Booth L-9)

Brown Instrument Company, Div. of Minneapolis-Honeywell Regulator Company. Will exhibit indicating, recording, automatic control instruments and auxiliary equipment used in the production, fabrication and heat-treatment. Instruments for automatically controlling the temperature of electrically heated and oil or gas fired furnaces will be demonstrated in operation. These will include electrically and pneumatically operated thermometers for die-casting machines, tempering tanks and other services up to 1200 deg. F., and also electrically and pneumatically operated control potentiometers for use with thermocouples or radiation pyrometers for hardening, brazing and annealing furnaces or other services up to 3400 deg. F.

Other displays will include the new Optimatic, a high-speed recording pyrometer, which will be shown in operation, motor operated valves, pressure gages, flow meters, CO_2 meters and resistance thermometers in both recording and automatic control models. (Booth N-22)

Foxboro Company. Will exhibit a complete line of indicating, recording and controlling instruments for the metal treating industry, among the instruments to be featured being the new and improved units, such as the Stabilog potentiometer controller with deviation record, the cupola air-weight controller, the stabilog temperature controller, and the potentiometer recording pyrometer. (Booth L-1)



Illinois Testing Laboratories, Inc. Exhibiting their complete line of portable and wall type indicating pyrometers, single and multipoint; distant reading resistance type thermometers; portable and wall type single point and multipoint; the "Alnor" velometer for the instantaneous direct reading of air velocity. This instrument indicates directly on a scale the air velocities in feet per minute without the necessity of timing or any mathematical calculations. There will also be on display a new type of controller, exhibited for the first time. (Booth N-26)

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Leeds & Northrup Company. Their complete line of Micromax temperature instruments, consisting of the new Silver Anniversary strip-chart recording controller, round-chart recorder, indicating controller and non-indicating controller will be in operation.

A special demonstration of Micromax electric control will show how temperatures are regulated by proportioning heat-input to demand. Three control systems will be demonstrated, one without droop corrector, one with manual droop corrector, and one with automatic droop corrector. This company will also display tempering and hardening furnaces, as described in another section. (Booth I-15)

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Partlow Corporation. Exhibiting temperature controls, for both gas and electric, limit controls, dial thermometers, safety gas valves, safety pilots.

Pyrometer Service & Supply Corporation. On display will be pyrometer supplies such as thermocouples, insulators, protecting tubes, and lead wire. (Booth B-18)

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C. J. Tagliabue Mfg. Company. A complete line of TAG photo-electrically balanced potentiometer pyrometers will be displayed prominently together with a display of the latest developments in modern pressure spring instrumentation. Magnetic clutch flow instruments will also be displayed together with thermometers, hydrometers, and oil testing instruments. (Booth M-15)

Wheelco Instrument Company. A display of production models of all Wheelco indicating and indicating controlling pyrometers will be mounted on panels. A feature of the display will be a Wheeco no-contact control operating a small electric furnace, together with a recording instrument showing a graphic record of the control. There will also be shown an enlarged working model of the Wheelco no-contact system of control, showing in complete detail the radio principle that makes it possible to obtain control action without any contact or mechanical means in the measuring circuit. Other displays include a new instrument for liquid level control and warning, in operation; a new "Limitrol" that acts to protect the furnace or the load from temperatures beyond which it is desired to heat; a "Flame-otrol," a new flame protecting device that uses the flame as a conductor, and upon failure instantaneously cuts off the main fuel line. (Booth I-32)

Welding Equipment

Air Reduction Sales Company. (Booth G-7)

American Brass Company. A featured section of their exhibit will be a welding demonstration booth, demonstrating both oxy-acetylene and electric arc welding methods with bronze rods. There will also be demonstrated the long arc high voltage welding of copper. This company will also exhibit a selection of high-strength copper alloys, as noted elsewhere. (Booth C-21)

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Bastian-Blessing Company. A display of cutting and welding torches and welding accessories. (Booth L-19)

General Electric Company. In operation for demonstration purposes will be two sizes of portable motor generator welders and a gasoline-driven portable welding generator. There will also be on display different types and sizes of electrodes and three welding transformers. As described under *Furnaces*, this company will also display in operation a controlled-atmosphere, mesh-belt brazing furnace. (Booth E-23)

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Hobart Brothers. Exhibiting (in operation): The complete line of Hobart "Simplified," 40-volt arc welders in sizes ranging from 75 to 400 amperes. Arc welding process on both ferrous and non-ferrous metals—light gauge sheet metal and heavy sections—in various applications. Photographs and actual samples of welded parts and assemblies. (Booth B-15)

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Lincoln Electric Company. In operation will be the new dual continuous control on their new "Shield-Arc S.A.E." welder, which will be the feature attraction of their display. Both voltage and current of the new welder can be varied in a continuous sequence of fine increments. Other equipment demonstrated will be the new "SA-150" small welder with a rated capacity of 45 to 200 amp. which is insulated with Class "B", noninflammable, insulation, permitting operation at sustained peak loads without danger of burn-outs. Latest developments in arc welding electrodes will be shown and demonstrated. These include "Toolweld" for hard-facing tools and dies; "Aerisweld" for welding bronze, brass and copper, "Chromeweld 4-6" for welding 4 to 6 per cent chromium steel, and numerous other electrodes for welding various metals and alloys. There will also be a full line of the latest in electrode holders, welding cables, protective shields and other welding accessories. (Booth F-23)

Linde Air Products Company. Exhibiting recent outstanding developments of the oxy-acetylene process, and the advances of machine cutting will be particularly featured. (Booth O-30)

P. R. Mallory & Company, Inc. A display of Mallory metals and alloys—Elkonite, Elkaloy A Metal, Mallory 3 Metal, Mallory 53 Metal, Mallory 100 Metal—and all types of Mallory water-cooled holders. Spot welding tips, seam welding wheels, flash welding dies and various forms of castings, forgings and special shapes. (Booth H-26)

Metal & Thermit Corporation. The complete line of Murex heavy mineral coated electrodes together with a number of test specimens and sample welds made with Murex will be on display. There will be a welding booth for demonstrating electrodes. (Booth H-27)

Safety Gas Lighter Company. A complete line of gas lighters, both for welders' use and fixed installations on various gas appliances, including hand gas lighters for consumer use, will be on display. The feature of this exhibit will be a complete arrangement of each and every type of gas lighter which has been manufactured since 1901. This exhibit will show the evolution of this type of equipment over a span of 35 years. (Booth I-33)

Una Welding, Inc. In operation will be a full-automatic shielded arc welding equipment with Una automatic welding heads to automatically feed the wire down to the work. In feeding this wire to the work it passes through a separate unit known as the Una-taper, and a tape fed from the reel is automatically wound around the wire. Other displays include the complete line of coated welding rods and a display of various types of welds to meet different welding requirements. (Booth H-23)

Union Carbide Company. (Booth O-30)

Williams & Co., Inc. Demonstrations of arc welding using the many types of welding rods that this company manufactures will be in operation. The exhibit will be designed to demonstrate the activities and services of this company in nickel, aluminum, brass and copper welding, including welding electrodes, welding machines, welding rod and accessories. There will also be on display various samples of boiler tubes. (Booth O-39)

Wilson Welder & Metals, Inc. (Booth G-7)

Plant and Shop Equipment

American Car & Foundry Company. Electric rivet, bar and billet heaters, featuring the a.c.f. Berwick electric six-foot bar heaters, for heating any diameter stock from ½ in. up to 1 in. This heater has water-cooled electrode, "electric eye" for controlling the temperature, and air cylinder for opening and closing the movable electrodes. The a.c.f. Berwick electric full-automatic hopper-fed heater has full-automatic movement of the electrode jaws controlled by the "electric eye". Other exhibits include an a.c.f. Berwick two-electrode Type "L" forging heater for bars ⅝ in to 1½ in. diameter and any length from 1 in. to 24 in.; an a.c.f. two-electrode Berwick Rivet Heater; an a.c.f. Berwick horizontal Type "C" heater for heating any diameter stock up to 5 in. and for heating any length of billet up to 4 ft. or longer. (Booth E-32)

American Foundry Equipment Company. An operating exhibit of the Wheelabrator will be on display, showing how it cleans castings, descales forgings, cleans heat-treated parts and prepares other metals for final finishes. The booth will be decorated with enlarged photographs of installations of the Wheelabrator Tum-Blast. Wheelabrator multi-rotary table, Wheelabrator cabinet and Wheelabrator automatic production unit. There will also be displayed the airless abrasive cleaning method. (Booth M-48)

The Bullard Company. A demonstration unit showing the operation of the Bullard-Dunn electro-chemical process for descaling metals. In addition, there will be a moving picture demonstration of the Bullard-Dunn continuous rotary immersion machine as applied to an actual commercial installation of the process. On display there will be a variety of work samples done by the various Bullard-Dunn commercial installations. (Booth M-54)

G. S. Blakeslee & Company. Exhibiting a spiral type oil quenching and washing machine for automatic handling of parts that have been heat-treated, quenched in oil and are to be cleaned. There will also be demonstrated the Blakeslee line of degreasing machines for removing oil and grease prior to plating, painting, assembly, or inspection. (Booth L-51)

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Chapman Valve Mfg. Company. Exhibiting a layout of the Chapmanizing process with a display of material that has been treated by this process, as well as technical information relative to the process. (Booth O-18)

Crown Rheostat & Supply Company. Equipment used in plating and polishing, such as plating barrels, centrifugal dryers, utility plating barrel, and polishing lathe will be exhibited. There will also be introduced a new anode for chromium plating. Another feature exhibit will be a newly designed hanger arm frame for holding cylinders in the plating barrels. (Booth L-46)

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A. P. de Sanno & Son. Machines for cutting metals with abrasive disks. A complete line of both cutting disks and grinding wheels will be displayed. Their Type "F" Radiac bench machine and Type "J" wet cutting machine which will be shown in operation. (Booth L-5)

De Walt Products Corporation. Exhibit will include two metal-cutting machines, both in operation, one machine cutting ferrous and non-ferrous stock, both wet and dry. The other machine will be their automatic tube cutting machine which will be the feature of their display. (Booth L-53)

Grob Brothers. Grob modern die making equipment consisting of open and band saws, other metal band saws, continuous-motion filing machines, and Grob saw band brazing device will be exhibited. (Booth E-2)

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Hardinge Brothers, Inc. Precision machine tools and equipment to be displayed include an inclosed-head precision ball-bearing bench lathe unit, an inclosed-head precision ball-bearing hand screw machine unit, an inclosed-head precision ball-bearing vertical head unit, a pedestal type milling machine with inclosed head, and a sleeve bearing precision bench lathe. Various styles of collets, feed fingers and machine equipment will be on display. (Booth L-14)

Lakeside Steel Improvement Company. Exhibiting samples of general heat treating, nitriding, champanizing, carburizing, aerocasing, blueing, and flame hardening samples.

Marburg Brothers, Inc. New and improved Moore jig borers, a precision sawing and filing machine, a Thiel cutting band saw and a vertical punch and form shaper will be shown in operation. (Booth L-50)

***8** Latest developments in oxy-acetylene flame-cutting machines, such as this one, will be demonstrated by Linde Air Products Company*

***9** Hardinge Bros. will exhibit in operation this bench type precision ball bearing milling machine with 8 spindle speeds*

***10** This semi-automatic machine for cutting light-wall tubing will be exhibited by the DeWalt Products Corporation*

***11** Among the exhibits of Marburg Bros. will be this Thiel precision sawing and filing machine with an automatic power feed*

Pangborn Corporation. Photographs representing complete line of Pangborn blast cleaning and dust collecting equipment, including Roto-blast centrifugal units, also some blast cleaning units on display. Complete line of blast cleaning accessories including hose, helmets and "certified" steel abrasives. (Booth P-27)

Spencer Turbine Company. Three recent developments will be exhibited, the "Midget" 1/3 hp. turbo-compressor for individual air supply; a 5 hp. stainless steel turbo for handling corrosive gases; a 7½ hp. 1750 r.p.m., 1½ lb. turbo-compressor in continuous operation, supplying air to various exhibits, and a 2 hp. Spencer portable vacuum cleaning system for factory cleaning and for the reduction of dust hazard in the chemical, silica and other industries. (Booth N-34)

Syncro Machine Company. A high-speed insulating machine for serving fibrous and web insulation on solid and stranded wires and cords. The machine will be in operation, serving wires with one mil insulating papers and cellulose films. Features of the machine include elimination of gear and belt drives by the employment of electrically synchronized motors. The machine is completely electrically controlled. (Booth N-1)

Laboratory Equipment

Bausch & Lomb Optical Company. Exhibiting a new research metallographic outfit that has just been completed, for work with bright field polarized light and dark field. The magnifying range is from a low limit of 2.5X to the highest magnification possible with oil immersion objective and high power eyepieces. The equipment consists of the inverted microscopic units; new and powerful illuminating system, an 8x10 camera, a supporting bed, a new stand, a large cabinet for accessories and plate holders and a cushioned stool adjustable for height. (Booth D-23)

Baldwin-Southwark Corporation. In operation, a Southwark-Emery universal testing machine equipped with the new Tate-Emery multi-range load indicating dial, first time publicly shown. High-speed R. R. Moore rotating beam fatigue testing machine using standard size specimens. (Booth P-15)

Adolph I. Buehler, Chicago. In operation are A-B specimen cutting machines; A-B bakelite presses; A-B specimen grinders; A-B specimen polishers; A-B specimen holders; also latest metallographic miscroscopes of Bausch & Lomb, Leitz and Carl Zeiss, manufacture. (Booth N-10)

Detroit Testing Machine Company. Will feature a direct reading Brinell machine, a universal testing machine, and a direct reading conveyor Brinell. Other exhibits will include a portable tensile tester having a capacity of 4000 lb. and weighing 22 lb.: a torsion tester of the bench type, suitable for testing light wire, rod, screws, and similar parts; and a sheet metal or ductility tester of a portable type and hand operated, weighing 25 lb. and having a capacity up to 1/16 in. plate. (Booth N-54)

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G. N. Krouse. Exhibiting a high-speed repeated stress machine of the cantilever type using small inexpensive test specimens of the notched and polished type. Also on display will be a high-speed fatigue machine adapted to test wire in a range of sizes of from 1/32 to 3/16 in. diameter. There will also be a fatigue testing machine for sheet metals, using a specimen designed for constant stress over about 1 in. of the length of the specimen. (Booth Q-20)

E. Leitz Inc. Showing a regular line of metal microscopes, photomicrographic apparatus, grinding and polishing machines, dilatometers and similar equipment. An entirely new instrument on display will be the Tyndallometer for the determination of dust in atmospheres. It is built on photometric principles and permits accurate measurement of the intensity of the Tyndall beam, the intensity of which is related to the contents of dust in the air. This will be the first showing of this instrument in America. Other exhibits will include a work shop control and measuring microscope and a universal microscope with photomicrographic camera. (Booth H-14)

Magnetic Analysis Corporation. The dual method type magnetic testing equipment and the laboratory type inductoscope equipment for the rapid non-destructive inspection of steel will be displayed. (Booth D-4)

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Tinius Olsen Testing Machine Company. The following equipment will be shown in operation: A 60,000 lb. capacity universal all-hydraulic loading and weighing testing machine having three hydraulic dial indicators; a 20,000 lb. capacity pendulum weighing mechanical operating machine with gear box drive, provided with their latest developed high magnification electric elongation recorder; strain gage; verifying ring; adjustable extensometer; direct motor driven Brinell hardness tester; stiffness testing machine for testing the stiffness of sheet metal and wire; filament stiffness testing machine for light stock provided with impact test attachments; universal impact testing machine, and a balancing machine for the balancing of rotating parts. (Booth B-8)

Pittsburgh Instrument & Machine Company. Exhibiting in operation will be a Diamo-Brinell testing machine with diamond indenter, power-operated Brinell machine, hand-operated Brinell machine, Brinell microscopes, direct-reading Brinell instrument, depth indicator for Brinell tests, Brinell calibrator for checking Brinell machines. (Booth G-34)

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Wilson Mechanical Instrument Company, Inc. Exhibiting in operation, a "Rockwell" hardness tester, "Rockwell" superficial hardness tester, and "Rockwell" hardness tester, with gooseneck for testing inner surfaces of tubes or rings. Also work support accessories, spares and renewals for "Rockwell" tester. (Booth C-25)

Carl Zeiss, Inc. Microscopes and accessories for the examination of metals and photomicrographic apparatus for routine examination as well as research work. Two Metallographs will be equipped with bright field, dark ground, as well as polarized light illuminators requiring no special adjustment to change from one type of illumination to the other. Shown for the first

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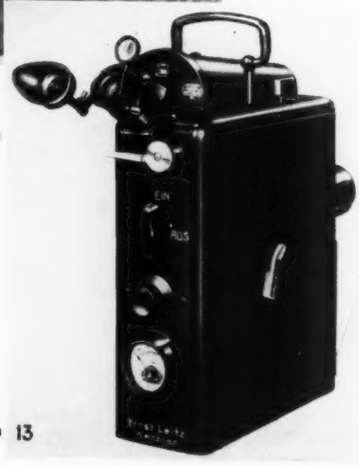

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12 ***Bausch & Lomb will show their new metallographic research outfit***

13 ***Dust control is a relatively new problem. E. Leitz will exhibit this new machine for measuring the dust concentration in atmosphere***

14 ***New universal testing machine to be exhibited by Detroit Testing Machine Co.***

time will be a new spectrum camera together with a highly efficient spark generator, the instrument requiring no adjustment whatsoever with the exception of inserting the electrode and focusing the image of the spark. Other displays will include the spectrum projector and the photometer. (Booth C-33)

Supplies and Miscellaneous Products

American Cyanamid & Chemical Corporation. Aerocase case hardening compounds; sodium cyanide; cyanide case hardening compounds; electroplating chemicals; and chemicals to the ferrous and non-ferrous industries will be displayed. (Booth N-47)

Anderson & Sons. Exhibit will consist of etched and lithographed articles of all descriptions, particularly etched metal products. Examples of etched aluminum, brass, zinc, stainless steel and other metals and also prefinished metals will be on display. (Booth N-51)

Armstrong Cork Company. An exhibit of insulating brick and insulating firebrick for high temperature insulation on all types of heated equipment. (Booth L-11)

Babcock & Wilcox Company. An animated display will be presented, showing the unusual savings effected through the use of B&W insulating firebrick, and featuring their characteristics. Data on B&W 80 firebrick, B&W junior firebrick, and B&W mortars and plastics will be available, as well as information on special forms of construction. (Booth N-18)

Botfield Refractories Company. (Booth N-49)

Carborundum Company. Displaying a complete exhibit of its principal abrasive and refractory products used in the metal working industries. The most recent models of Carborundum-Hutto honing heads, and other special devices. (Booth O-38)

Case Hardening Service Company. Carburizing compounds, heat treating salts, carburizing boxes and pots, non-case anti-carburizing paint, cleancoat lead pot covering will be displayed. (Booth G-23)

Dayton Rogers Mfg. Company. Representative group of metal stampings made under their special die stamping process. (Booth E-3)

E. F. Houghton & Company. Will have on display improved pickling inhibitors, liquid carburizers, new drawing compounds, metal cleaners, cutting oils, wire drawing agents, industrial lubricants, leather belting and leather packing. (Booth I-8)

Macklin Company. An exhibit consisting of a series of enlarged photographs of grinding operations and a display of grinding wheels. A cut-off machine will be in operation. (Booth C-26)

Manhattan Rubber Manufacturing Division. Exhibiting in operation, abrasive cut-off wheels cutting alloy castings and finishing wheels for stainless steel of a new type, recently developed. (Booth H-2)

Mullite Refractories Company. On exhibit will be standard brick shapes and special shapes made from Mullite. Also a Moore Lectromelt Steel Melting Furnace with a refractory roof made of Mullite to demonstrate the adaptability of Mullite for electric furnace melting. (Booth O-15)

Norton Company. The main feature of the exhibit will be an illustrated and illuminated background with a large opening in the center, behind which will pass on a conveyor a continuous parade of Norton products, including grinding wheels of all kinds, refractories for heat-treating furnaces, and for electric melting furnaces, and laboratory ware for steel analyses. There will be also on display the new Norton "B-E" bond tool grinding wheels recently introduced to the trade. (Booth Q-12 and Q-16)

Parker-Kalon Corporation. Exhibit will be in the form of a large back panel, 22 ft. long, the center unit of which will dramatically, through motion displays, convey the advantages of their hardened self-tapping metal screws. Below these units will be displayed greatly enlarged replicas of their different types of screws with suitable inscriptions describing the purposes for which each type is intended. The ease and speed with which the screws can be applied will be demonstrated by actual assembly operations.

D. A. Stuart & Company. A display of "Extreme Pressure" of "EP" lubricants, industrial oils and greases. A lubricant testing machine in operation will demonstrate the difference between EP and non-EP lubricants. In addition there will be exhibited cutting oils, grinding compounds, drawing lubricants and a display of sample parts produced with the well known lubricants. (Booth L-25)

Program of Technical Sessions

Annual National Metal Congress

October 19 to 23, Cleveland, Ohio

American Society for Metals

Monday Morning, Oct. 19—Statler Hotel

"The Retarding Effect of Certain Metallic Elements on Graphitization," by H. S. Schwartz, H. H. Johnson and C. H. Junge, National Malleable & Steel Castings Company.

"Cadmium Alloy for Bearings," by C. F. Smart, Pontiac Motor Company.

"Diffusion of Hydrogen Through Nickel and Iron," by W. R. Ham, Pennsylvania State College.

High-speed motion picture showing behavior of quenching mediums during quenching—I. N. Zavarine, Massachusetts Institute of Technology.

SIMULTANEOUS SESSION

"The Effect of Titanium on Some Cast Ferrous and Non-ferrous Metals," by J. A. Duma, Norfolk Navy Yard.

"Effect of Titanium on the Hardness and Microstructure of Heat-Treated 18 per cent Chromium Steel Ingots," by R. E. Bannon, Titanium Alloy Mfg. Company.

"The Production of Flakes in Steel by Heating in Hydrogen," by R. E. Cramer, University of Illinois.

Monday Afternoon—Public Auditorium

"Notes on Continuous Gas Carburizing," by R. J. Cowan, Surface Combustion Corporation.

"Differential Hardening by Induction," by M. A. Tran, Park Drop Forge Company, and W. E. Benninghoff, Ohio Crankshaft Company.

"The Continuous Heat-Treatment of Cold Rolled Strip," by N. P. Goss, Cold Metal Process Company, and T. B. Bechtel, Electric Furnace Company.

Monday, 4:30 P. M.—Public Auditorium

Lecture on Physical Testing of Metals, by H. D. Churchill, Case School of Applied Science.

Monday, 8:00 P. M.—Public Auditorium

Lecture on X-Ray Analysis, by K. R. VanHorn, Aluminum Company of America.

Tuesday Morning, Oct. 20—Statler Hotel

"Some Effects of Small Additions of Vanadium to Eutectoid Steel," by J. G. Zimmerman, R. H. Aborn and E. C. Bain, U. S. Steel Corporation.

"Influence of Aluminum on the Normality and Grain Size of Steel," by G. R. Brophy and E. R. Parker, General Electric Company.

"A Study of the Effect of the Aluminum Addition on the Structure of a Quenched Carbon Steel," by H. W. McQuaid, Republic Steel Corporation.

Tuesday Afternoon—Public Auditorium

"Effect of Overload on the Fatigue Properties of Several Steels at Various Low Temperatures," by H. B. Wishart and S. W. Lyon, University of Illinois.

"Austenitic Stainless Alloys: Their Properties and Characteristics," by V. N. Krivobok and R. A. Lincoln, Allegheny Steel Company.

"Slip Twinning and Cleavage in Iron and Silicon Ferrite," by C. S. Barrett, G. Ansel and R. F. Mehl, Carnegie Institute of Technology.

Tuesday, 4:30 P. M.—Public Auditorium

Lecture on Physical Testing of Metals, by H. D. Churchill.

Tuesday, 8:00 P. M.—Public Auditorium

Lecture on X-ray Analysis, by K. R. VanHorn.

Wednesday Morning, Oct. 21.

ANNUAL MEETING AND CAMPBELL LECTURE

Wednesday Afternoon—Public Auditorium

"Magnetic Properties of a Series of Basic Open-Hearth Slag Samples," by B. A. Rogers and K. O. Stamm, United States Bureau of Mines.

"Basic Open Hearth Slag Control," by Earnshaw Cook, American Brake Shoe & Foundry Company.

"A New Tool for the Control of Quality Steel Making," by G. T. Motok, Republic Steel Corporation.

"Equilibrium in the Reaction of Hydrogen with Iron Sulphite in Liquid Iron and the Thermodynamics of Desulfurization," by John Chipment and Ta Li, American Rolling Mill Co.

Wednesday, 4:30 P. M.—Public Auditorium

Lecture on Physical Testing of Metals, by H. D. Churchill.

Wednesday, 8:00 P. M.—Public Auditorium

Lecture on X-Ray Analysis, by K. R. VanHorn.

Thursday Morning, Oct. 22—Statler Hotel

SYMPOSIUM ON THE PLASTIC WORKING OF METALS

(Papers to be presented are listed below)

SIMULTANEOUS SESSION

"X-Ray Study of Preferred Orientations in Pure Cold-Rolled Iron-Nickel Alloys," by D. McLachlin, Jr., and W. P. Davey, Pennsylvania State College.

"Application of X-Ray Diffraction to the Study of Fatigue in Metals," by C. S. Barrett, Carnegie Institute of Technology.

"X-Ray Diffraction Studies of Distortion in Metals," by G. L. Clark and M. M. Beckwith, University of Illinois.

Thursday Afternoon—Public Auditorium

SYMPOSIUM ON THE PLASTIC WORKING OF METALS

(Papers to be presented are listed below)

SIMULTANEOUS SESSION

"Further Study of a High-Carbon High-Chromium Tool Steel," by W. H. Wills, Ludlum Steel Company.

"Importance of Boundary Attack in the Etching of Steel Specimens," by B. L. McCarthy, Wickwire Spencer Steel Company.

"Physical Properties of Axle Shafts," by H. B. Knowlton, International Harvester Company.

Thursday, 4:30 P. M.—Public Auditorium

Lecture on Physical Testing of Metals, by H. D. Churchill.

Friday Morning, Oct. 23—Statler Hotel

SYMPOSIUM ON THE PLASTIC WORKING OF METALS

(Papers to be presented are listed below)

SIMULTANEOUS SESSION

"Conversion of Elongation Data from One Form of Test Piece to Any Other," by E. J. Janitsky, Carnegie-Illinois Steel Corporation.

"Behavior of Some Low Alloy Steels in the Single-Blow Drop Test," O. W. Ellis, Ontario Research Foundation.

"The Fracture of Carbon Steel at Elevated Temperatures," by A. E. White, C. L. Clark, University of Michigan and R. L. Wilson, Timken Steel & Tube Company.

Friday Afternoon—Public Auditorium

SYMPOSIUM ON THE PLASTIC WORKING OF METALS

(Papers to be presented are listed below)

SIMULTANEOUS SESSION

"Investigation of Fatigue Strength of Axles, Press Fits, Surface Rolling, and Effect of Size," by T. V. Buckwalter and O. J. Horger, Timken Roller Bearing Company.

"Endurance of Gear Steels at Two Hundred Fifty Degrees Fahrenheit," by A. L. Boegehold, General Motors Corp.

"Recovery of Cold Worked Nickel at Elevated Temperatures," by Erich Fetz, Wilbur B. Driver Company.

Friday, 4:30 P. M.—Public Auditorium

Lecture on Physical Testing of Metals, by H. D. Churchill.

SYMPOSIUM ON THE PLASTIC WORKING OF METALS

To be held on Thursday morning and afternoon, October 22, and Friday morning and afternoon, October 23. Morning session will be held at the Statler Hotel, afternoon sessions at the Public Auditorium.

"Laws and Fundamentals of Plastic Deformation," by A. V. deForest, Massachusetts Institute of Technology.

"Metallic Single Crystals and Plastic Deformation," by S. L. Hoyt, A. O. Smith Corporation.

"Creep Characteristics of Metals at Elevated Temperatures." by C. L. Clark and A. E. White, University of Michigan.

"Interpretation and Use of Creep Results," by J. J. Kanter, Crane Company.

"Elastic Properties and Their Relationship to Strain Hardening," by M. F. Sayre, Union College.

"Effect of the Shape of the Test Piece Upon the Energy Needed to Deform Materials in the Single Blow Drop Test," by O. W. Ellis, Ontario Research Foundation.

"Hot Working, Cold Working and Re-Crystallization Structure of Metals," by N. P. Goss, Cold Metal Process Company.

"Factors Relating to the Production of Drop and Hammer Forgings," by Adam Steever, Columbia Tool Steel Co.

"Hot Press and Upset Forging," by J. H. Friedman, National Machinery Company.

"Extrusion of Metals," by D. K. Crampton, Chase Brass & Copper Company.

"Cold Heading—Bolts, Rivets and Nails," by R. H. Smith, Lamson & Sessions Company.

"The Ductility of Steel in Wire Drawing," by H. B. Pulsifer, American Steel & Wire Company.

"Cold Forming Processes—Drawing Rods and Bars," by J. E. Beck, Jones & Laughlin Steel Corporation.

"Cold Drawing Processes: Making of Tubing," by Horace Knerr.

"Cold Rolling of Mild Steel Sheets and Strip," by Anson Hayes and R. S. Burns, American Rolling Mill Company.

"Some Factors Affecting the Plastic Deformation of Sheet and Strip Steel and Their Relation to the Deep Drawing

Properties," by Joseph Winlock and R. W. E. Leiter, Edward G. Budd Mfg. Company.
"Cold Working of Hollow Cylinders by Auto-Frettage," by N. E. Woldman, Eclipse Aviation Corporation.
"Damping Capacity: Its Variation and Relation to Other Physical Properties," by G. R. Brophy, and E. R. Parker, General Electric Company.

American Welding Society

All technical sessions and committee meetings will be held in the Hotel Cleveland

Monday, 9:45 A. M., Oct. 19—Ball Room

Business Session, President J. J. Crowe, presiding

Report on society activities by President Crowe.
Teller's report on election of officers.
Award of Samuel Wylie Miller Memorial Medal.
Review of committee and section activities by Chairmen.
Discussion.

Monday, 2 P. M.—Ball Room

A. E. Gibson, chairman, The Wellman Engineering Company
E. Vom Steeg, vice-chairman, General Electric Company

Welcome address by local official.
"Fundamentals of Metallurgy of Welding," by E. S. Davenport and Dr. R. H. Aborn, United States Steel Corporation.
"Multi-Layer Oxyacetylene Pipe Welding," by R. M. Rooke, F. C. Saacke and A. N. Kugler, Air Reduction Sales Company.
High-speed motion pictures of various welding processes, by E. Vom Steeg, General Electric Company; W. E. Crawford and Walter Richter, A. O. Smith Corporation.

Monday, 6:30 P. M.—Parlor

Dinner and meeting of Board of Directors.
Review of society activities, appointment of committees and officers; new business.

Tuesday, 9:45 A. M., Oct 20—Ball Room

H. M. Boylston, Chairman, Case School of Applied Science
E. R. Fish, Vice-Chairman, Hartford Steam Boiler Inspection & Insurance Company.

"Heating by the Proximity Effect," by Edward Bennett, The University of Wisconsin.
"Impact Tests of Welds at Low Temperatures," by Otto Henry, Brooklyn Polytechnic Institute.
"Characteristics of a Universal Welding Generator," by N. F. Ward, University of California.

Tuesday, 2 P. M.—Ball Room

H. W. Gillett, Chairman, Battelle Memorial Institute
R. E. Kinkead, Vice-Chairman, Consulting Engineer

FUNDAMENTAL RESEARCH IN WELDING

"Welded Beam-Column Connections," by Inge Lyse, Fritz Engineering Laboratory, Lehigh University.
"Circuit Characteristics and Arc Stability," by S. C. Osborne, Wilson Welder and Metals Company, Inc.
"Welded Structural Brackets," by C. D. Jensen, Lehigh University.

Tuesday, 7:30 P. M.

Conference and meeting of Fundamental Research Committee, Bureau of Welding Research and Engineering Foundation. H. M. Hobart, Chairman, General Electric Company. This conference is scheduled for university research workers in the fundamentals of welding.

Wednesday, 9:45 A. M., Oct. 21—Ball Room

A. F. Davis, Chairman, The Lincoln Electric Company
C. A. McCune, Vice-Chairman, Magnaflux Corporation

"Brazing with Silver Solders," by Robert H. Leach, Handy & Harman.
"Importance of Design Control for Welded Piping Systems," by T. W. Greene, The Linde Air Products Company.
"Principles of Surfacing by Welding," by E. W. P. Smith, The Lincoln Electric Company.
"Technique for Resistance Welding Ferrous and Non-Ferrous Sheet Metals," by E. I. Larsen, P. R. Mallory & Company.

Wednesday, 2 P. M.—Ball Room

Hugh H. Dyar, Chairman, Linde Air Products Company
J. B. Tinnon, Vice-Chairman, Metal & Thermit Corporation

"Procedures for Control of Welding Parts," by G. H. Moore, Jr., Newport News Shipbuilding and Dry Dock Company.
"Welding Copper and Its Alloys—A Review of the Literature," by Ira T. Hook, American Brass Company.
"Resistance Welding of Dissimilar Metals," by R. T. Gillette, General Electric Company.
"Thermit Welding," by J. H. Deppeler, Metal & Thermit Corporation.
"An Exploration of a Modern Metallic Arc," by L. J. Larson, A. O. Smith Corporation.

Thursday, 9:45 A. M., Oct. 22

Joint session American Welding Society with American Society of Mechanical Engineers

C. W. Obert, Chairman, Union Carbide & Carbon Research Laboratories, Inc.
Milton Male, Vice-Chairman, United States Steel Corporation

"Welding Design," by C. H. Jennings, Westinghouse Electric & Manufacturing Company.
"Alloy Steels and Their Weldability," by A. B. Kinzel, Union Carbide & Carbon Research Laboratories.
"Arc Welding of Structural Alloy Steels," by W. L. Warner, Watertown Arsenal.

Thursday, 2 P. M.

Joint session American Welding Society with American Society of Mechanical Engineers

H. F. Henriques, Chairman, Air Reduction Sales Company
S. M. Weckstein, Vice-Chairman, Timken Roller Bearing Company

"Rolled Steel in Machine Construction," by H. G. Marsh, Carnegie Steel Company.
"Welding Heavy Machinery and Equipment," by C. A. Wills and F. L. Lindemuth, The Wm. B. Pollock Company.
Discussions by E. E. Tross, United Engineering & Foundry Company, and F. O. Leitzell, Lewis Foundry & Machinery Company.
"Modern Resistance Welding Developments," by A. E. Hackett, Thomson-Gibb Electric Welding Company.

Thursday, 7 P. M.

Dinner dance with entertainment

American Society of Mechanical Engineers

A. E. Gibson, Chairman, Wellman Engineering Corporation
Guy Hubbard, Vice-Chairman, Penton Publishing Company

"Applications of Copper Alloy Welding," by I. T. Hook, American Brass Company.
"Welding of Monel Metal and Pure Nickel," by F. A. Flocke and J. G. Schoener, International Nickel Company.
"Welding the Aluminum Alloys," by G. O. Hoglund, Aluminum Company of America, New Kensington, Pa.

Friday, 2 P. M.

R. E. W. Harrison, Chairman, Chambersburg Engineering Company
D. M. Gurney, Vice-Chairman, Warner & Swasey Company

"Principles Involved in Selecting Casting Versus Welding," by J. L. Brown, Industrial Motor Department, Westinghouse Electric & Mfg. Company.
Discussion of Radiographic Inspection of Welded Refinery Equipment and Steel Plate Construction by H. R. Isenburger, St. John X-Ray Service.
Discussion of the Use of Magnaflux for Inspecting Welds.

Morgan Engineering Company

REVIEW OF NOTEWORTHY PAPERS ON WELDING

Abstracts of papers to be presented at sessions of American Welding Society and American Society of Mechanical Engineers at the National Metal Congress. For copies of complete papers apply to the society concerned, the address of each being 29 W. 39th Street, New York, N. Y.

High-Speed Motion Pictures of Flash Welding

W. E. CRAWFORD and WALTHER RICHTER
A. O. Smith Corporation

To be shown at a session of the American Welding Society in the Ball Room of the Hotel Cleveland, Monday afternoon, Oct. 19.

● It has always been a question what happens during flash welding. To the observer, flash welding consists of a series of blinding flashes, from which the process derives its name, and a shower of incandescent particles flying in all directions. The authors used a high speed movie camera to study the phenomena of flash welding.

Edge-on motion picture frames of flash welding mild steel were made at speeds up to 1,200 frames per second. A careful study of these motion pictures showed that the flashing operation employed in flash welding is not characterized by a condition of uniform arcing. That is to say, at the point of contact of the surfaces to be welded together an arc forms momentarily, lasts about one five-hundredth of a second, and is replaced by another arc at some other point of contact of the two surfaces. During the period of a single flash or arc there occur at irregular intervals violent expulsions of incandescent particles of steel. The expulsion may occur from both sides of the contacting surfaces simultaneously or may be confined, in unusual cases, to one side.

The motion pictures of the flash in flash welding are being studied by Messrs. Crawford and Richter in conjunction with oscillographic records of the electric current consumed by the flash.

Multi-Layer Oxyacetylene Pipe Welding

R. M. ROOKE, F. C. SAACKE
and A. N. KUGLER

To be presented at a session of the American Welding Society in the Ball Room of the Hotel Cleveland, Monday afternoon, Oct. 19.

● It has been the practice to deposit oxyacetylene weld metal in a single layer. But Messrs. Rooke and Saacke have discovered by experiment that in welding heavy-wall steel pipe the weld should be made in more than one layer. First a thin layer of weld metal from 2 to 6 in. long is deposited in the bottom of the groove between two pipes to be joined. After this layer has cooled below a red heat another layer is deposited, and so on until the entire groove between the plates is filled and the weld is completed. For a pipe an inch thick, four layers are usually sufficient, the last layer deposited being as thin as possible.

Although the multi-layer may seem at first more complicated than the single-layer method, tests have shown that the reverse is the case in practice.

The multi-layer welding method simplifies much of the welder's difficulties in manipulating a large pool of molten steel, especially in welding heavy-wall pipe. Incidentally, the simplification speeds up welding so that multi-layer welds are quicker to make than single layer welds. Besides simplifying the welder's job, the multi-layer method consumes less welding rod and fuel gases—oxygen and ascetylene—than the single-layer method. From the cost standpoint, the new multi-layer method is therefore superior for thick pipes to the old single-layer method.

The authors also show that welds made by the multi-layer method are practically as strong as, and considerably more ductile and shock resistant than, single-layer welds. The improvement in toughness of the multi-layer welds results from the small size of the individual layers. Since a small layer of molten steel is deposited more rapidly and freezes more quickly than a large one, a multi-layer weld is exposed to the contaminating influence of the atmosphere for a shorter time than a single-layer weld.

The industrial significance of the experiments by Messrs. Rooke and Saacke is explained by Mr. Arthur N. Kugler, who has applied the multi-layer method of oxyacetylene welding to the installation of high pressure steam piping in two modern power plants.

Metallurgical Aspects of the Welding of Steel

E. S. DAVENPORT and R. H. ABORN
U. S. Steel Corporation

To be presented at a session of the American Welding Society in the Ball Room of the Hotel Cleveland, Monday afternoon, Oct. 19.

● This paper gives a comprehensive explanation of all the changes in internal structure—or architecture as the authors aptly name it—that occur during all kinds of welding in steel. The multiplicity of changes occurring in steel during welding give rise to five distinct zones, which can be distinguished by means of photographs of the internal structure or architecture of steel. The photographs were prepared by means of a microscope capable of enlarging the structure up to 1,500 times.

Besides shedding much light on the scientific aspects of welding, the observations made by Messrs. Davenport and Aborn show that welds in steel are surrounded by two zones; one softer than the original steel, the other harder and more brittle. Just how soft or hard the zones may be, depends on the precise conditions of the welding operation and also upon the composition of the steel.

In ordinary steels the hard and soft zones are very little, if at all, different from the original steel. In some alloy steels containing copper, nickel, chromium, or other alloying elements, the hard zone may be extremely hard or the soft zone excessively soft. The carefully reasoned outline of the metallurgical principles of welding given by Messrs. Davenport and Aborn provides a basis for overcoming the difficulties experienced with troublesome steels.

Tensile Impact Resistance of Welded Joints

OTTO H. HENRY
Polytechnic Institute, Brooklyn, N. Y.

To be presented at a session of the American Welding Society in the Ball Room of the Hotel Cleveland, Tuesday morning, Oct. 20.

● Professor Henry decided at the outset of his studies that the usual methods of testing for brittleness are extremely artificial and may be misleading. The usual test for brit-

tleness, or more technically expressed, resistance to shock or impact, is carried out on a sample of metal in which a notch is carefully cut. But it is well known that in most engineering construction, as in turbines and electric motors, and especially in welded structures notches are avoided wherever possible. Welders always endeavor to deposit welds free from notches or other abrupt changes of section.

For these reasons Professor Henry decided to adopt a method of testing for brittleness which involved smooth specimens, rather than notched ones. The ideal test for the purpose is the so-called tensile impact test, where a polished cylindrical specimen, about 3 in. long and $\frac{1}{4}$ in. diam. is pulled apart by a sudden impact blow delivered by a heavy pendulum traveling at about 10 m. per hr.

In order to rupture a specimen at a specified low temperature, it is cooled in a mixture of alcohol and ether cooled by dry ice. The specimen tends to become slightly cooler rather than warmer, upon withdrawal from the cold bath, on account of the rapid evaporation of the alcohol-ether mixture. The relative brittleness or toughness of the specimen is determined from the swing of the pendulum and the increase in length of the specimen just before fracture.

Preliminary tests were made on unwelded metals to serve as a comparison with welded specimens. In these tests Professor Henry studied the toughness of several well-known materials and obtained some surprising results which are given in the paper, together with the results of tests on butt welds, atomic hydrogen welds, brazed joints and oxyacetylene welded joints.

Welded Beam-Column Connections

PROF. INGE LYSE and G. J. GIBSON
Lehigh University, Bethlehem, Pa.

To be presented at a session of the American Welding Society in the Ball Room of the Hotel Cleveland, Tuesday afternoon, Oct. 20

● One of the leading engineering laboratories in the country—the Fritz Engineering Laboratory—has recently conducted an exhaustive investigation dealing particularly with the rigidity of welded buildings, the results of which are reported in this paper.

The investigation at Lehigh has provided those who design welded buildings with the solution of their most pressing problem, namely, in what way should the floor beams of a building be joined to the upright columns? There are, of course, many possible ways of joining but which method is most economical and is it consistent with accepted notions of safety? The method of design developed at Lehigh is applicable to a wide range of lightweight beams of moderate length.

The function of the floor beams of a steel building is to carry the weight of the floor resting upon it and to transmit the floor load to the upright columns which in turn transmit the load to the foundations. Of the many possible methods of attaching a floor beam to a column, the best appears to involve the use of steel angles. A steel projection or angle is welded to each of two columns. The ends of the beam are then supported on the angles and additional angles welded to the top of the beam and to the column.

The Lehigh tests showed the best arrangement of angle seats so that failure of the welded beam-column under excessive load will not occur at the angle connections but at the center of the beam. Such an arrangement is at once most economical and strongest because the full strength of the floor beam is utilized.

The tests upon which the method of design is based, were made on full-size floor beams welded to heavy structural steel columns. The welding was performed by means of covered electrodes, which are steel rods, 18 in. long and from $\frac{1}{8}$ to $\frac{1}{4}$ in. thick.

An important advantage of welding over the other types of joining was clearly shown in the course of the tests. It was found that the strength and rigidity of the welded connection could be changed simply by distributing the welding over different areas of the angle seats. In this way, savings of up to one-third in the size of the floor beam was made possible by altering the rigidity of the connection. When other methods of joining are used changes of rigidity can be made only by eleborate alterations in the type of connections.

The top-angle connection—so-called because the angles are welded to the top as well as to the bottom of the floor beam—is shown by the Lehigh tests to be the most suitable type of connection for light weight floor beams, and was found to have considerable reserve strength.

Welded Structural Brackets

CYRIL D. JENSEN
Fritz Engineering Laboratory, Lehigh University

To be presented at a session of the American Welding Society in the Ball Room of the Hotel Cleveland, Tuesday afternoon, Oct. 20.

● How does the designer compute the dimensions of welded brackets capable of supporting given loads with provisions for overloads of assigned amounts? Also, how do brackets that are designed so as to require as little welding and material as possible carry the loads imposed upon them? These questions are clearly and concisely answered in this paper.

The first step taken by Professor Jensen in his investigation was the testing of small celluloid models of eight types of welded brackets. The transparent celluloid models were subjected to loads similar to those expected in service and examined in polarized light by the photoelastic method. By this method the "flow" of load from the beam at the point of support on the bracket, through the bracket to the column is made visible. The method reveals those portions of each bracket which carried the most load, and those which carried the least.

Portions of the bracket carrying little load as revealed by the photoelastic pattern can be cut away from the bracket with little loss of strength. The process of cutting away useless portions of the model bracket is continued until all parts of the bracket are equally stressed. The flow of load from beam to column is then uniform and the most economical design is evolved.

Welded steel brackets were then tested. Altogether 24 full size welded brackets were subjected to increasing load until fracture occurred. During the tests the changes in shape of important parts of each bracket were measured by means of extensometers. A crack in the coat of whitewash with which the specimens were painted indicated failure.

With information available from both the celluloid models and the full size welded specimens, the final step in the design of welded brackets was to discover a design formula. A design formula is presented by means of which brackets may be designed with simplicity and accuracy, for each of the many conditions of loading likely to be encountered in service. It is interesting to note that the formula proposed by Professor Jensen is in excellent agreement with the theoretical calculations regarding the bracket as a unit of homogeneuos material. The tests therefore showed that welded brackets may be considered for the purposes of structural design as continuous members integral with column and beam.

When and How Silver Solders Are Used

By R. H. LEACH

Handy & Harman, Bridgeport, Conn.

To be presented at a session of the American Welding Society in the Ball Room of the Hotel Cleveland, Wednesday morning, Oct. 21.

● In both soldering and welding, metal parts are joined by depositing molten metal in the gap between the parts and permitting the molten metal to solidify. In welding, however, the edges of metal parts are themselves melted; in soldering the metal parts to be joined are never melted. The welded joint is created simply by fusion, the soldered joint depends for its strength on other factors, such as adsorption and adhesion.

Silver soldering is no different in principle from soldering with plumber's or tinsmith's solder, which is familiar to every one. But whereas ordinary solder is made of tin and lead, and melts at about 300 deg. F., silver solder is made of silver and copper, with usually some zinc, and melts at higher temperatures; 1,200 to 1,600 deg. F. The applications of silver solders in industry are authoritatively discussed in this paper by Mr. R. H. Leach, manager, Handy & Harman, who also describes up-to-date methods, for using the solders.

The advantages of silver solder over other types of solder are: 1. strength; 2, resistance to vibration and shock; 3, resistance to corrosion; 4. ease of fabrication. Practically all metals that can be heated without danger to 1,200 deg. F. can be silver soldered.

The strongest silver soldered joints are made with the remarkably small gap of 1½ thousandths of an inch between the parts to be joined. Being so thin, the joint has a neat appearance. In many cases the silver soldered joint is invisible to the naked eye. Tests of silver soldered assemblages are described, and also the method of silver soldering.

Other developments discussed include dip brazing, in which the joint to be made is dipped in a bath of molten silver solder, and resistance brazing. In the latter method inserts are used as described above, but the heat is supplied electrically rather than by a torch. These and other new developments are rapidly extending the fields of application of the highly efficient process of silver soldering.

The Principles of Surfacing by Welding

E. W. P. SMITH

Consulting Engineer, Lincoln Electric Company

To be presented at a session of the American Welding Society in the Ball Room of the Hotel Cleveland, Wednesday morning, Oct. 21.

● Primarily the adoption of surfacing for a particular application is governed by a delicate balance between properties and price. The question is: Is it cheaper to fuse a thin layer of expensive material on inexpensive mild steel, or to make the entire part of the expensive material? In the majority of cases, surfacing by welding is not only demanded by the nature of the service, but is less expensive. A precise answer to the question is given by the author with reference to surfacing by arc welding. The process of surfacing by arc welding is described in detail.

It is pointed out that the electrode is often a special hard metal, such as Hadfield manganese steel, for use on worn rail ends. Electrodes are on the market today, however, to meet specific requirements other than hardness. There are electrodes which produce a surface that will not chip or crack under shocks, such as hammer blows. Others are resistant to the grinding action or abrasion due to contact of metal with rock, sand, or other metals. Abrasion resistant electrodes are used for surfacing the jaws of rock crushers and the teeth of steam shovels. But the composition of the electrode for the rock crusher, for example, would be entirely different from the electrode for steam shovel teeth to operate in sandy ground.

Electrodes have also been invented for producing surfaces resistant to corrosive chemicals, such as acids, and to the action of corrosive gases at high temperatures. Even ordinary air corrodes steel at a red heat. By applying a thin layer of an electrode of appropriate composition, a large mass of inexpensive mild steel may be rendered immune to corrosive conditions of any degree of severity. Different types of electrodes may be used singly or in combination for a given application.

The examples quoted show that if the conditions of service are known, the selection of a suitable electrode is readily made. Once the selection of the electrode is made, the decision whether surfacing is economical can be made on the basis of a simple calculation explained in detail. Charts and methods of computation will facilitate the application of surfacing by arc welding to new products and to the building up of worn equipment.

An Exploration of a Modern Welding Arc

L. J. LARSON

A. O. Smith Corporation

To be presented at a session of the American Welding Society in the Ball Room of the Hotel Cleveland, Wednesday afternoon, Oct. 21

● The center of attention in the study of the arc welding process is the space between the tip of the electrode and the plates to be joined. Visual examination of the arc space with the aid of protective glasses to avoid glare fails to show how the steel is transferred from the electrode to the pool of weld metal. Nor have high speed motion pictures of the welding arc provided a complete explanation of the welding process. Mr. Larson's ingenious experiments with welding arcs have, however, provided a consistent explanation of metallic arc welding with covered electrodes. Although, as he himself points out, we now know fairly well what happens in the arc space, we still do not know why it happens.

Mr. Larson's experiments showed first of all that more heat is available in the arc of a covered electrode than in the arc of a bare electrode. Consequently, the covered electrode is melted faster and welding is more rapid with the covered electrode than with the bare. The extra heat in the covered electrode also provides better fusion with the plate metal than is possible with bare electrodes.

The author then presents in detail the results of his investigation of the phenomenon of arc welding. The experiments made by Mr. Larson provide the materials for a mental picture of the modern welding arc. Within the blinding glare of the arc space tiny globules of molten steel are speeding from the covered electrode to the parts to be welded. At the same time a blast of harmless gases evolved from the coating is rushing outwards from the arc space preventing access of air to the pool of weld

metal. The weld metal deposited in this way by the covered electrode is equivalent to high-grade steel and has the same strength and ductility as steel produced by the steel mill.

Welding Design

C. H. JENNINGS
Westinghouse Electric & Mfg. Company

Abstract of paper to be presented at the joint session of The American Welding Society with the American Society of Mechanical Engineers, Thursday morning, Oct. 22.

● Although welding has been extensively used in the fabrication of engineering structures for a number of years, there is still, as pointed out by the author, a decided lack of knowledge among engineers concerning the fundamental factors governing a satisfactory welded design. In addition there is a lack of agreement among designers as to the methods of calculating weld stresses and the correct working stresses to employ for different types of joints. This paper contains a discussion of a number of variables such as the selection of the proper joint, the calculation of weld stresses, the determination of working stresses and safety factors, and the important features governing a good welded design.

An analysis is made between butt and fillet welds in an effort to assist the designer in the selection of the proper type. Theoretical and practical aspects such as stress concentrations resulting from discontinuities in form, fabrication difficulties, welding costs, and distortion problems are considered.

The calculation of weld stresses in different types of joints is discussed and suitable formulas are recommended on the basis of their agreement with test results and their general applicability and acceptance in present design practice.

Working stresses and safety factors for butt and fillet welds, as determined on the basis of static and dynamic tests, are given. A table of recommended working stresses for bare and coated electrode welds subject to all types of loading is also given. This table is based upon joints made in ordinary low carbon structural grade steel.

A number of important design features that are essential in the design of economical welded structures are given. These features include the recommended minimum size of fillet welds for given plate thicknesses, the application of intermittent welds in design, and the influence of joint design on the economical fabrication of butt joints.

Arc Welding of Structural Alloy Steels

W. L. WARNER
Welding engineer, War Department Watertown Arsenal, Watertown, Mass.

Abstract of paper to be presented at the joint session of the American Welding Society with the American Society of Mechanical Engineers, Thursday morning, Oct. 22.

● Two principal factors, the chemical composition of the steel and the heat effects of welding on the steel, determine the ease or difficulty with which the steel structure can be fusion welded. Other factors include heat-treatment, details of the design, type of service for which the structure is intended, availability of suitable welding materials and the skill of the personnel.

In discussing the hardening in the heat-affected zone, the author gives the practice of the Watertown Arsenal in making tests on ½-in. thick plates welded in different manner. These studies at the Watertown Arsenal cover the welding characteristics of several of the new low-alloy steels in comparison with the structural nickel-steel and the plain carbon steel of varying percentages of carbon content, ranging from 0.15 per cent to 0.50 per cent. For the latter, the author expresses the opinion that a stress-relieving heat-treatment at 600 deg. C. for six hours will reduce the hardening of the heat-affected zone to a level only slightly higher than the plate metal as rolled.

Tables given in the paper show the tensile properties obtained from arc butt welded joints on ½-in. structural alloy steel plates using different types of electrodes. The results of tests and examination of the welds are also reported.

Another table shows the maximum hardness set up in the heat-affected zone for various alloy compositions, bringing out the relationship between the hardening effect and the amount of the alloying element present in the steel. The tabulated data is discussed and analyzed, one conclusion being that the weldable alloy should have a carbon content limited to about 0.25 per cent. In nickel steel the hardness of the heat-affected zone is not seriously affected by the nickel content if the carbon content is less than 0.25 per cent. But for a 2.00 per cent nickel steel, a 100 per cent increase in carbon content results in an 80 per cent increase in hardness of the heat-affected zone, while for a 3.50 per cent nickel steel, this increase is 55 per cent. Thus the increase in tensile properties should be obtained, not by increasing the carbon content but rather by increasing the alloy content of the steel. And at all times, for good weldability the carbon should be not more than 0.25 per cent.

Elongation and tensile impact values as obtained by tests are discussed and analyzed for butt welds, including low-temperature impact data on various structural carbons and structural nickel steel plates, and copper-nickel-molybdenum steel. It is indicated that the nickel, nickel-copper and the manganese-molybdenum steel show the highest tensile strength and the nickel and nickel-copper steels show the highest value of proportional limits.

Alloy Steels and Their Weldability

A. B. KINZEL
Chief Metallurgist, Union Carbide & Carbon Research Laboratories, Inc.

Abstract of paper to be presented at the joint session of the American Welding Society with the American Society of Mechanical Engineers, Thursday morning, Oct. 22

● In the welding of low-alloy, high-strength steels, it matters little what combination of alloy is used, providing that the alloy content is well balanced and the physical properties are attained with a carbon content of 0.14 per cent or less in those low alloy steels giving 75,000 lb. per sq.in. ultimate strength, or a carbon content of 0.22 per cent or less in the steels possessing 90,000 lb per sq.in. ultimate tensile strength.

Alloy content of the current low-alloy steels is sufficiently low so that no diffculty relative to the flowing properties and controlability of the weld puddle is encountered. The most serious problem has probably been the air-hardening of the steel in the zone adjacent to the weld, but in general no difficulties from air hardening are experienced in steel containing 0.14 per cent of carbon or less. In the higher-

strength steels with carbon at approximately 0.20 per cent, the air-hardening problem becomes a serious one, as explained in the paper.

The residual internal stresses developed as a result of the welding operation are discussed and the author explains why he rates gas fusion welding as the most suitable type for these steels, electric arc-welded butt joints coming next on the list.

In discussing the mechanism of stress relieving by plastic deformation and by elastic deformation, the author points out that the ductility of the base metal in the 75,000 lb. per sq.in. steel is so great that the most severe internal stresses are frequently relieved by room temperature plastic deformation of the base metal.

Many of the low-alloy steels now on the market contain ½ per cent or more of copper, for the purpose of obtaining increased corrosion resistance. But although this provides a moderate increase in tensile strength in the as-rolled condition, a further increase in tensile strength should not be sought by heat-treating as the effect is completely destroyed by welding. Also, the user continuously faces the risk of losing the strength by local heating after the finished product has been put in the user's hands.

The welding of heat-treated S.A.E. steels is also discussed, particularly with reference to the type of welding rods to be used. It is pointed out that there is little advantage in using a rod of the same composition as the steel, as this is only one way of fulfilling the single requirement that the response to heat-treatment of the deposited metal may be of the same character as that of the metal being joined. Specially designed welding rod fulfills this requirement as well as the additional requirements imposed by the welding operation, and the author mentions the types of rods to be used. The effect of the addition of Columbium to the low carbon austenitic stainless steels of the 18-8 type is explained.

Rolled Steel in Machine Construction

H. G. MARSH

Carnegie Steel Company

Abstract of paper to be presented at the joint session of the American Welding Society with the American Society of Mechanical Engineers, Thursday afternoon, Oct. 22.

● Last year 80,000,000 lb. of electric welding rods were used. On the basis of 25 to 40 lb. per ton, it is estimated that between 2,000,000 and 3,000,000 tons of steel were welded, indicating that welding has become so common that the public accepts it without comment. According to the author's figures, it has been estimated that 50 to 60 per cent of the weight of all the machinery in the field of power shovels and road building equipment has been converted from castings to rolled steel, while in the field of presses, brakes, electric cranes and heavy industrial equipment, the conversion has been from 15 to 50 per cent. In spite of all this, in the opinion of the author, there is much to be done before the benefit of this type of construction will be realized to the proper extent, it being estimated that the conversion from casting to welded rolled steel for machinery in general is only about 15 per cent.

The author then discusses the apparent apathy toward welding on the part of many engineers which he attributes to them not being sufficiently informed on the possibilities and demonstrated performance of welded construction. With reference to the sales resistance to welded products, this is indicated by the fact that in many instances all evidence of welding is carefully concealed and that apparently pains are taken to omit any reference to welded construction in the advertisements of such products.

After discussing this phase of the problem, the author points out that designing engineers should be given more data on welded joints and more information on the properties of weld metal, although a first-hand knowledge of the technical details of the welding process is not required of the designing engineer. What is needed is simple and reliable data on the strength of welded joints, analysis of stresses in such joints, and the structural properties obtainable in welded joints.

Welding Heavy Machinery and Equipment

C. A. WILLS and S. L. LINDEMUTH

The William B. Pollock Company

Abstract of paper to be presented at the joint session of the American Welding Society with the American Society of Mechanical Engineers, Thursday afternoon, Oct. 22

● The authors point out that when the engineer goes about designing a welded steel structure, he should think only of what can or cannot be done in welded steel, and not handicap his design from the start with the limitations imposed by some other construction process. In welded steel construction about the only limits to size and shape is imposed by machining or shipping requirements. Thick and thin members can be welded together, strong rigid sections such as box-shaped sections, which are difficult to even approximate in castings, are easy to make; and various materials can be combined in one piece. These and similar considerations dictate that the designer should not handicap his welded design by making a Chinese copy of a casting, but he should think only of the possibilities and limitations of the welding process itself.

By considering the welded job as a welded job and not as a "just as good" imitation of some other kind of construction, the designer is quite often able to get much better results than could be obtained with another type of construction from the point of view of strength, rigidity, cost and appearance. And in some instances he is able to adopt a type of construction which could not be made at all if welding were not available.

This paper is illustrated with numerous photographs of welded products including gear cases, hot metal cars, machine tools, steel mill ladles, steel mill equipment, gear blanks, rolling mill engine frames, and similar machinery. In some instances both the welded design and cast design are illustrated for comparison.

In discussing some of the design problems, the authors point out that there is no fixed rule that certain thicknesses of plates require welds of a certain size or shape. Sometimes a certain thickness of plate may be sufficient to carry the load but not sufficient to take the required shape and size of weld, in which case the thickness of the plate may have to be increased or the design changed in order to get in the amount of welding required.

Too much welding has its disadvantages in that excessive welding runs up the cost with no compensating advantage and at the same time, the more weld metal there is the greater will be the tendency for distortion as the weld metal cools.

Various methods of getting the necessary amount of welding in the place available are described. Other factors discussed include the use of two or more kinds of material in one structure and the use of reinforcing such as ribs, gussets, and knee braces.

Welding the Aluminum Alloy

G. O. HOGLUND

Aluminum Company of America

Abstract of paper to be presented at the session sponsored by the American Society of Mechanical Engineers, Friday morning, Oct. 23.

● The three welding processes at present of commercial significance in assembling aluminum parts are the torch or gas welding, metallic arc welding, and electric resistance welding as exemplified by spot, seam or line welding. In addition to this there are a number of other welding processes, but they are still in the experimental stage or in limited production. These include butt and flash welding, carbon arc welding, atomic hydrogen welding, automatic metallic and carbon arc welding and several others. Torch or gas welding is discussed in detail.

After taking up the various types of aluminum alloys that are suitable for welding, the author discusses the effects of the welding processes and the resulting welds. This discussion includes gas welding and the fluxes used to counteract the oxide coating that is formed and the preparation of the joints for gas welding. Metallic arc welding is described and discussed in a similar manner. Different examples of welded aluminum structures are shown.

In discussing electric resistance welding the author states that while this process is just reaching its production stage, development and research work on this problem has been conducted for several years. The equipment and apparatus required is described, with special emphasis on the electronic timing equipment.

The paper concludes with a discussion of the strength of spot welds and the resistance of such welds to corrosion. Tables are included to give the approximate machine setting for spot welding aluminum, and another table gives the breaking load of spot welds in various aluminum alloys.

The paper will be illustrated with ten lantern slides.

Welding of Monel Metal and Pure Nickel

F. G. FLOCKE and J. G. SCHOENER

International Nickel Company

Abstract of paper to be presented at the session sponsored by the American Society of Mechanical Engineers, Friday morning, Oct. 23.

● After a review of the history and difficulties of welding Monel metal and nickel, the authors point out that whereas these earlier materials were hot short between 1,260 deg. F., the materials of current production permits a 380 deg. bend through a complete temperature range from 1,200 deg. F. to 2,200 deg. F.

Similarly, it is brought out that the developments that have taken place in the welding electrode has advanced from bare wire such as used in the earlier days, with the flux applied separately, to the manufacture of flux-coated electrodes of Monel and nickel, a development which began about five years ago.

Regular cold drawn Monel wire was used for many years for the core of electrodes. In the light of present day practice, results were only fair though, on standards of a few years ago, they were considered quite satisfactory. It was found that where a light wash coating of a mineral flux gave only fair arcing characteristics, an improvement in arcing characteristics was obtained where a slagging type of coating was used. The thickness of coating was multiplied several times but since the thicker coatings were applied by hand dipping, the problem of concentricity became paramount. Attempts at applying several thin coatings to build up a heavier total thickness were mildly satisfactory. It was found also that with these plain dip coatings, a slight amount of porosity still persisted in the deposited weld.

The usefulness of aluminum as a deoxidizer in nickel alloys was known, but advantage had not been taken of this in welding. Finally it was decided that the use of aluminum in the form of fine wire wrapped in a spiral around the 18 in. length of bare electrode, would serve a twofold purpose; first, it would aid in deoxidation, and it was hoped, eliminate porosity, and second, the spiral would serve as an excellent support for the flux coating applied by dipping. This procedure worked out very satisfactorily with both Monel and nickel and was used for several years. The more recent developments of coating by extrusion were applied, with the result that the extruded Monel electrode is commercially available now, whereas, the hand dipping practice is still followed in the case of nickel.

By its very nature, molten nickel has a great affinity for gases and when it freezes or solidifies, these gases are thrown off to form gas pockets or porosity, certainly an undesirable characteristic in welding. It was this condition which necessitated an investigation made about ten years ago with the object of making small additions to essentially pure nickel. These additions were important alloying elements which might control or at least "fix" this porosity. The outcome was a composition of nickel welding wire which had controlled amounts of titanium and magnesium and which measurably reduced the gaseous condition. This special nickel welding wire was adopted and is still standard for gas and electric welding wires for pure nickel. With gas welding, no porosity is evident, but with metallic arc welding of nickel it does occur occasionally. Current investigations are showing material progress toward the ultimate elimination of this porosity.

Both gas welding and arc welding are covered for both Monel metal and nickel. The procedure for welding various types of joints is given in detail, together with the procedure for welding with the carbon arc, which method is frequently applied to the intermediate range of gages from 0.037 in. to 0.62 in. Typical constructions made of Monel sheets by means of the carbon arc process are also described in detail.

This paper contains a number of valuable tables giving the mechanical properties of Monel and nickel, the strength of welds, the results of hardness tests on Monel welds after welding and after stress relief anneal, the physical properties of welded butt joints in Monel made by the metallic arc, and the strength of Monel welded to steel.

Applications of Copper and Alloy Welding

I. T. HOOK

Research Engineer, American Brass Company

Abstract of paper to be presented at the session sponsored by the American Society of Mechanical Engineers, Friday morning, Oct. 23

● This paper presents a brief survey of the use of copper alloys as welding material for joining copper alloys by various brazing and welding metals, for joining ferrous and other metals by copper alloy weld metal, and for building up wear and corrosion resisting surfaces of copper alloys.

Joints in thin and heavy walled tubing are illustrated by figures showing various forms of brazed and welded connections. The application of welded copper for locomotive fire boxes is discussed and also, a design of heat-exchanger wherein a large bundle of copper tubes were silver brazed into a deoxidized copper header.

In making the connection between the deoxidized copper tube sheet and the steel shell, one of the things that contributed to the success of the arrangement was the method of laying down the welding bead.

Four figures illustrating various forms of brazed or welded connections are shown. One is a fitting connection which is soft soldered or silver brazed, but may be a Tobin bronze brazed. Another is a simple butt weld in brass or copper pipe with a wall thickness of $\frac{1}{8}$ in. or more. Such a joint is commonly made with yellow bronze welding rods. It has uniform corrosion resistance when made with a deoxidized copper welding rod.

A taper weld connection designed for any size of pipe, of any wall thickness from the thinnest to the thickest, is also shown. It is usually made with silver brazing alloys, or with Tobin bronze, or as a fusion weld.

Hence nearly all commercial copper pipe and tubing is made of phosphorus deoxidized copper, there is no content of copper oxide to give trouble in the welding operation. But wherever it is possible to use diverse metals, soft solder, silver solder, or yellow bronze, such as Tobin, will be found easy to apply.

Details of methods of procedure for welding copper and copper alloys, including aluminum bronze and beryllium copper, and cuprous nickel containing 10 to 30 per cent nickel are given. The paper concludes with a detailed discussion of the field of use and the difficulties relative to brazing copper to steel, the atomic-hydrogen brazing process, silver brazing and bronze welding.

Selecting Casting Versus Welding

J. L. BROWN

Industrial Motor Department,
Westinghouse Electric & Manufacturing Company

Abstract of paper to be presented at the session of the A.S.M.E., Friday afternoon, Oct. 23.

● In this paper the author gives a comprehensive discussion of the question of casting versus welded design. After discussing the nature of the deposited weld metal at the joints of a welded structure, the author points out that the advantages to be gained by the welding method of fabrication are closely associated with and dependent upon the advantages of rolled steel. He then takes up the various advantages of the rolled steel welded structure such as the speed and efficiency of welding, the possibility of using thin sections, the adaptability of welded design for box-like structures, the elimination of pattern costs, the possibility of designing a suitable structure by the judicious selection of a few simple rolled steel parts joined by welding, and the advantage of quicker delivery possible for welded products that those made of castings.

On the other hand, if the character of the structure is such that standard rolled sections are not acceptable unless formed to a modified shape, on account of the appearance factor, and the number of pieces required is so small that the expense of tools required for forming the part to a more pleasing shape is not justified, the tendency will be to favor the casting method.

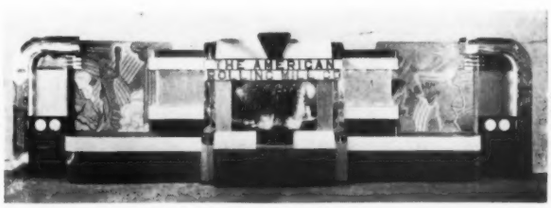
In the case of castings, there are also a number of distinct advantages, among them the availability of a variety of materials having widely different characteristics. These include not only steel but also the great variety of cast irons and semi-steels available and the myriad of non-ferrous metals and alloys, each particularly suited to a given purpose. Often they are difficult to displace by a welded steel substitute. For example, cast iron and semi-steels, comprising by far the greatest bulk of all castings made, have ideal wearing surfaces for break drums, rope sheaves, cylinders for internal combustion engines and similar parts. These castings are resistant to corrosion and may be produced with fair magnetic properties. Cast irons are used for a great variety of applications where stresses are low. On the other hand, the semi-steels provide up to double the strength of ordinary gray cast iron, while at the same time maintaining the advantageous machining characteristics of cast iron. The principal disadvantage of both the cast iron and semi-steels is that they are low in ductility and do not lend themselves readily to joining to other parts.

Malleable iron castings, though produced in comparatively small volume, are used where freedom from brittleness is important and where steel castings would be more difficult to make on account of the thin sections employed. In a similar manner the author points out the advantages of the numerous non-ferrous metal castings such as zinc, aluminum, magnesium alloys, brass and bronze.

Summing up this problem, the author states that where corrosion resistance is required, where ideal working surfaces are necessary, and where large quantities of irregularly shaped parts must be produced and subsequently machined, it will be difficult for the welded steel design to compete with that of gray iron or semi-steel castings.

Where the solution is not obvious it is recommended that a casting be designed first to secure the greatest efficiency in appearance, utility and cost. Obviously it will be useless to design a welded structure to compete with a poor cast design. The result may be much less efficient than the competitor's design. Also, it may be pertinent to say that it is not safe to assume that all existing cast designs are efficient designs and therefore safe criteria to use in making competing welded designs. There have been many welded designs made which were cheaper to produce than the cast design replaced but which could in turn be replaced by a still cheaper cast design.

The author then goes into further details in discussing the factors that will determine the choice between welded and cast construction. The paper will be illustrated with eleven lantern slides.



Aluminum Pressings— A New Type of Fabricated

AT SUCH an early stage in the development of aluminum pressings it is impossible to foretell just where they will find their greatest application, nor is it possible to predict, exactly, the ultimate limitations as to size and shape. Production thus far has been confined largely to articles of nearly symmetrical design, many of them cupshaped. Some have been straight-walled, and others flared or shaped. The more intricate designs have been limited to smaller parts. No attempt has been made as yet to develop a technique for producing other than fairly symmetrical shapes, but there is no reason why a technique for the production of all types of elongated and odd-shaped pressings cannot be developed for aluminum, the same as it has been for other metals.

One of the most successful and interesting pressings made commercially is the rotor magneto cover or dome-piece for an outboard motor. It is a shallow cup-shaped part about 7 in. in diameter and 2 in. deep, and bears a striking resemblance to a griddle cake dish cover, although it is heavier walled. The accuracy to which this part is made and the resultant advantages are typical of what can be obtained with pressings.

The accuracy of the magneto cover is illustrated by the fact that a circular magnet is inserted inside the dome and, with no machining, a close fit is obtained. The extremely small inside and outside drafts which characterize aluminum pressings are partially responsible for the close fit possible in the dome-piece, and they also result in the elimination of considerable machining in all aluminum pressings. At the present time, the minimum draft, inside or outside, is $\frac{1}{4}$ of 1 deg. Dimensions, particularly outside and inside diameters, can be held to close tolerances.

In order to attach the starter plate to the magneto cover, the latter is made with a lug at the center on the outside surface. The lug is formed during pressing, and without machining, it fits accurately into the recess provided in the starting plate. Three machine screws hold the two pieces together. The lug is shaped somewhat like a three-leaf clover so as to provide a place for each screw and at the same time not require as much metal as a circular lug of equivalent size.

Since pressings are limited in size and dimensions by the capacity of the presses, it is to be expected that as

Fig. 1—Press used for the production of large aluminum pressings

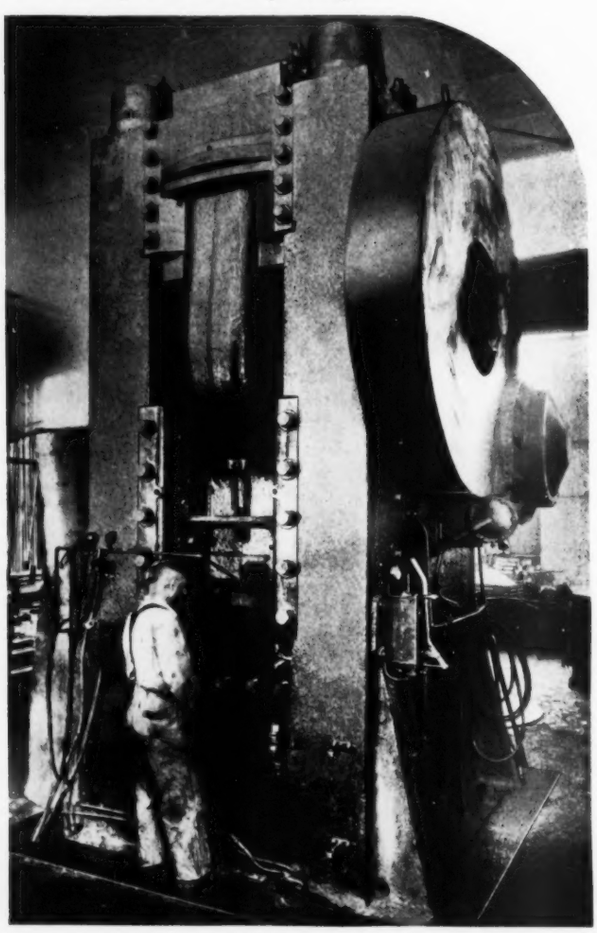
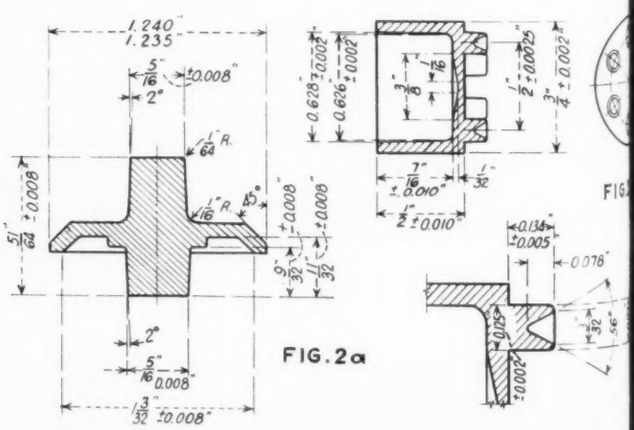


Fig. 2—Details of four small aluminum alloy pressings, showing typical designs and tolerances: (a) check valve for outboard motor, (b) connection with integral rivets for attaching handle to cooking utensil, (c) hydraulic brake piston, (d) hydraulic brake piston



Shapes

HARRY L. SMITH, JR. and
SETH G. MALBY
Aluminum Company of America

Because they possess a unique combination of physical characteristics, aluminum pressings promise to become one of the most useful forms in which that metal is obtainable

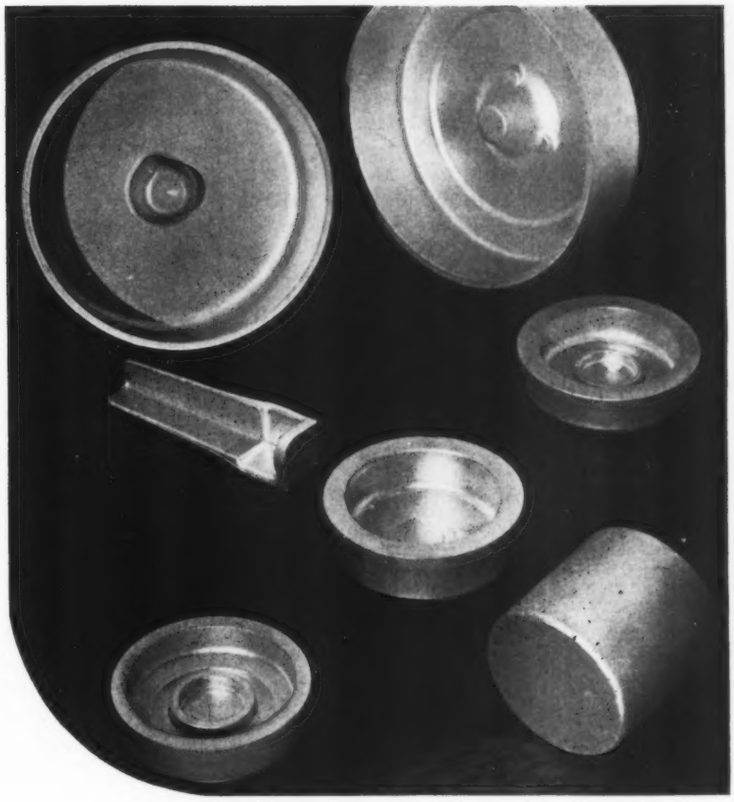


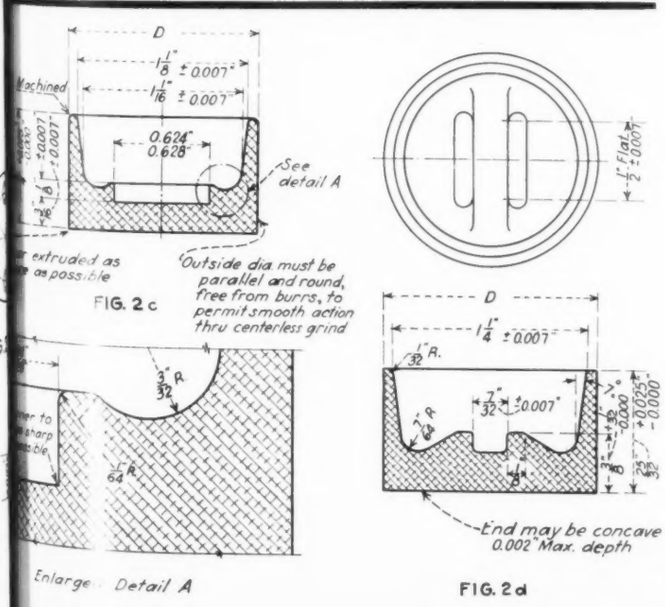
Fig. 3—Typical aluminum alloy pressings: two outboard motor rotor magneto covers, aircraft stringer splice, three end caps, and piston for auxiliary motor

the process develops the range between the maximum and minimum size pressings will broaden. With the present equipment, it is possible to produce pieces up to about 16 in. in diameter and weighing 20 to 25 pounds. The depth of the pressing obtainable depends upon the stroke of the press, the maximum being 10 in. to 12 in. in the case of straight-walled pressings and less than that amount if irregularly shaped. Numerous parts weighing less than one ounce are being made. Wall thickness of cup-shaped parts may vary over an extremely wide range, roughly $\frac{1}{32}$ in. to 2 in. Because of the nature of the process, the thickness of the bottom and side wall of cup-shaped pressings can be varied independently.

Pressings are made from specially shaped slugs of metal, squeezed into shape in a press. The slug is first placed in the die and then the ram is brought down with sufficient pressure to cause the metal to flow and fill the recesses of the die. The process is carried out either hot or cold, the larger pieces generally being made from preheated slugs. Some alloys are more difficult to press than others and consequently may require hot pressing for most shapes.

Presses are capable of high rates of production, which is one of their advantages over forging hammers and one of the factors contributing to the economy of the process. With every stroke of the press, one piece is completed, whereas a forging hammer often requires 10 to 15 blows to form a piece and some designs may require two or three series of blows with different dies before the piece is completed. The rate at which aluminum pressings are made compares favorably with that for stampings and impact extrusions.

All aluminum alloys capable of being forged or extruded can also be pressed, and in this classification are many commercial alloys. They present a wide range of mechanical properties and characteristics which suit them to a variety of applications. In tensile strength, for example, the alloys range from 13,000 to 65,000 lb. per sq.in. Because of the similarity between the mechanical properties of forgings and pressings, it is customary to design on the basis of the properties established for forgings. For the mechanical properties of heat-treat-



able and non-heat-treatable alloys see Tables I and II.

In some respects, the pressing operation results in more desirable physical characteristics than hammer forging. In a pressing, the metal is usually shaped by a single stroke of the press. Consequently, there is a continuous flow of metal, resulting in an exceptionally uniform grain structure throughout the pressing. The surfaces of pressings are smooth and free from the hammer marks frequently found on forgings and thus finishing is simplified and more economical.

Pressings are economical from another point of view; they permit a more efficient distribution of metal. A sheet stamping, for example, must be of substantially the same thickness throughout, but each section of a pressing need be made only heavy enough to carry the stresses expected in that particular section. Less metal is required and the parts are lighter in weight. Advantage is taken of this feature in pressed hydraulic brake pistons. They are formed with heavy heads and light side walls. The illustration shows several styles of hydraulic brake pistons made commercially as aluminum pressings. They are made from 51S alloy and, after forming, are heat-treated to produce maximum mechanical properties. The inside of the piston is shaped during the pressing operation to suit the particular conditions under which it operates. Some are slotted, and others are given lugs or a circumferential shoulder.

Table I—Mechanical Properties Specifications for Aluminum Pressings Made from Heat-Treatable Alloys

Alloy	Minimum Tensile Strength (lb./sq. in.)	Yield Strength* (lb./sq. in.)	Minimum Elongation (per cent in 2 in.)
14S-T	65,000	50,000	10
17S-T	55,000	30,000	16
18S-T	55,000	35,000	8
25S-T	55,000	30,000	16
32S-T	52,000	40,000	5
51S-T	40,000	30,000	12
A51S-T	43,000	34,000	12
53S-T	36,000	30,000	16
70S-T	50,000	40,000	16

* Stress which produces a permanent set of 0.2 per cent of the initial gage length.

Table II—Approximate* Mechanical Properties for Aluminum Pressings Made from Non-Heat-Treatable Alloys

Alloy	Tensile Strength (lb./sq. in.)	Yield Strength (lb./sq. in.)**	Elongation (per cent in 2 in.)
2S-O	13,000	4,000	35
2S-H	24,000	21,000	5
3S-O	16,000	5,000	30
3S-H	29,000	25,000	4
4S-O	26,000	10,000	20
4S-H	40,000	34,000	5
52S-O	29,000	14,000	25
52S-H	41,000	36,000	7

* Pressings are made from slugs in the annealed temper (designated as –O). The mechanical properties therefore depend upon the amount of cold work introduced into the piece during pressing and may run as high as the full hard temper (designated as –H).

**Stress which produces permanent set of 0.2 per cent of the initial gage length.

Many pressings are made with reinforcing ribs which is an effective method of strengthening and stiffening a part and requires a minimum amount of metal. Assembly costs are reduced by the use of pressings, since it is possible to include bosses, lugs, ears, hubs, and similar details in the design. In the case of the magneto cover, the deep boss on the inside is formed during the pressing operation, but if the part were made as a stamping, an assembling operation would be necessary.

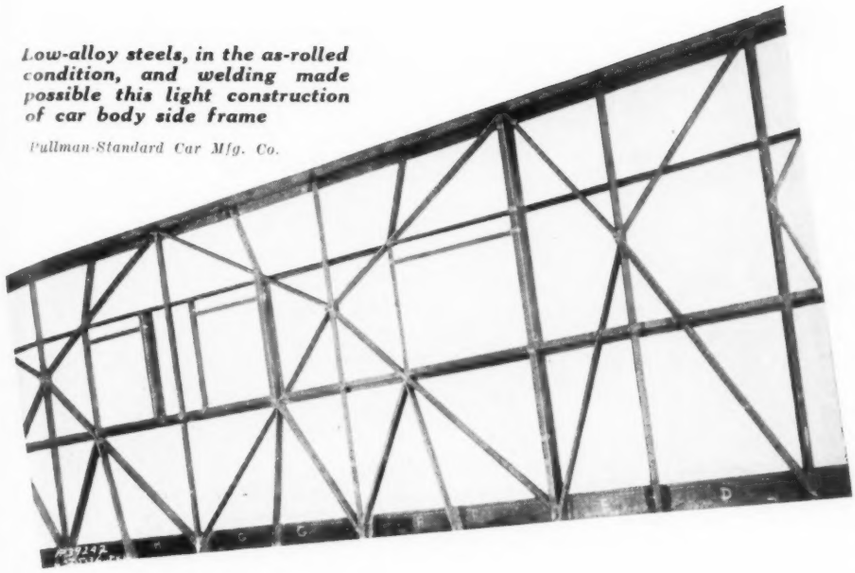
The inherent lightness of aluminum alloys is retained in aluminum pressings. In reciprocating parts, light weight is of considerable advantage in reducing the inertia which must be overcome in starting, stopping and reversing. Light-weight reciprocating parts also reduce bearing pressures. Light aluminum pressings are suitable for many parts of portable tools and outboard motors. They are tough and durable and stand up under severe usage. Their lightness is an advantage in keeping the weight of the tool or motor at a minimum. Pressings are finding some application for small aircraft parts where the design of the part lends itself to the pressing operation, and where pressing is more economical than other methods of fabrication.

A high degree of resistance to corrosion characterizes the aluminum alloys used for pressings and makes them suitable for service both indoors and outdoors. Alloy 53S possesses unusually high resistance to attack by marine atmospheres. Aluminum pressings may be coated by the Alumilite process to give the parts a surface which is exceptionally resistant to corrosion and which makes an excellent paint base, and is also extremely hard and resistant to abrasion. The coating is smooth, cannot peel off and is attractive in appearance. It may be employed in the natural aluminum color or it can be dyed various colors if desired.

One of the larger pressings made commercially is a bucket-shaped container having a diameter of approximately 8 in. and a depth of 7 in., not including the small base upon which it is mounted. In service, the part is rotated at 8,000 to 10,000 r.p.m. It is made of 53S alloy and has sufficient strength to withstand these high centrifugal forces. The pressing process is particularly well suited to the production of this part, since it is highly desirable that it be accurately and uniformly made so that it can be properly balanced. Because the pressing closely approaches the form and dimensions of the finished product, it requires a minimum amount of machining.

Die costs for pressings depend upon the size and design of the part, but in general they are about the same as forging and impact extrusion die costs. Large quantity production cuts the costs per piece and in some cases an experienced engineer can so design the part to be pressed that it will make a more economical job. In comparison with the advantages and economies which characterize aluminum pressings, die costs are not high.

Although aluminum pressings made to date have been limited largely to more or less symmetrical shapes, there is no doubt that eventually it will be possible to make a variety of odd-shaped pressings in aluminum, the same as in other metals. Each new design presents more problems to be solved, but the skill and knowledge acquired from this work is accumulating rapidly. Already, ample experience has been had to produce many types of pressings, and as soon as the requisite background is built up, it will be possible to produce all types of pressings in aluminum.



Low-alloy steels, in the as-rolled condition, and welding made possible this light construction of car body side frame

Pullman-Standard Car Mfg. Co.

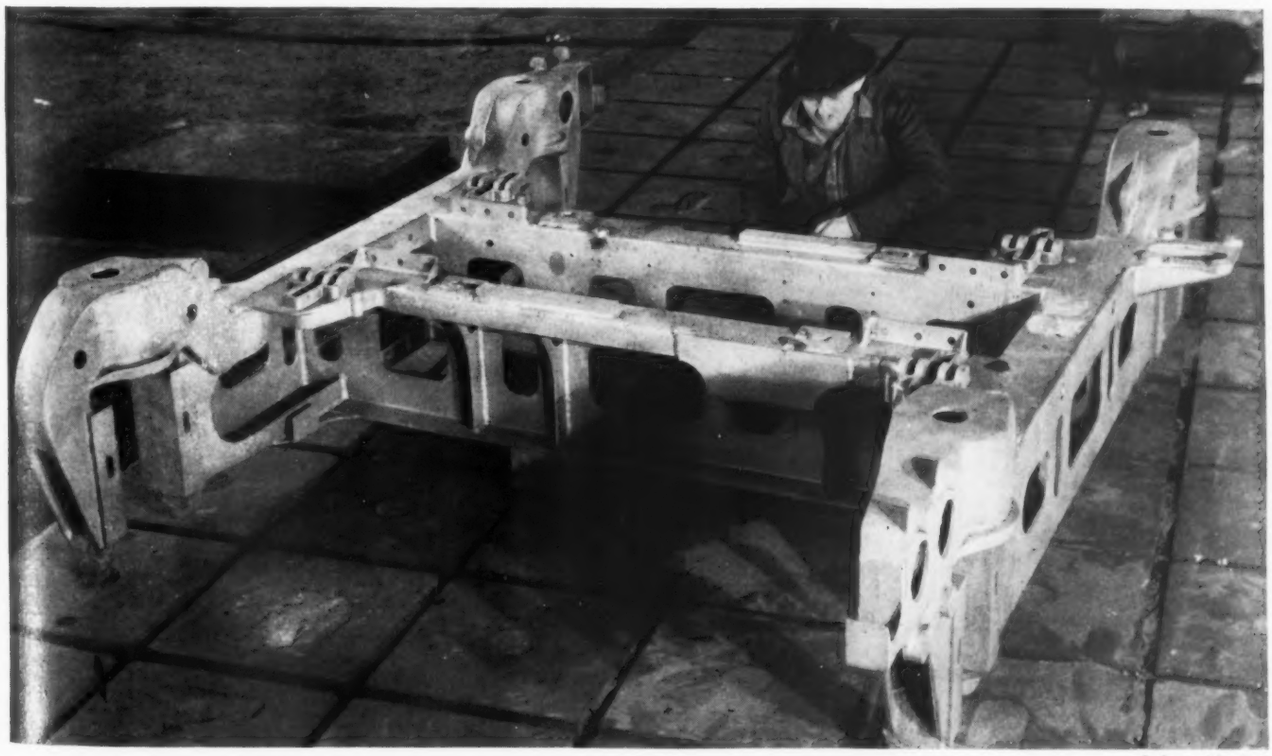
Design Factors Using Moderately Alloyed Steels

C. E. McQUIGG
Union Carbide & Carbon Research Laboratories, Inc.

ABOUT thirty years ago designers of cantilever bridges realized that the longest structures of that type theretofore built had reached the maximum span obtainable under the unit stresses permissible in steels then available. Believing that longer cantilevers would be required, an associate of the writer foresaw that their design would have to employ unit stresses considerably higher and that alloyed steels, almost necessarily without benefit of heat-treatment, offered the only hope. Observing that dead load, including that of the flooring, absorbed by far the largest part of the safe load-bearing capacity of a long cantilever bridge, he concluded that if the safe unit stresses could be materially raised above the 18,000 lb. per sq.in. which was then the limit, the weight of the load-bearing steel could be decreased more than proportionally.

These dreams of the earlier bridge builders and other structural engineers have now come true in the sense that alloy steels possessing high strength in the as-rolled condition are now available. In Table I are shown the principal characteristics of some of the moderately alloyed steels.

But the needs of industry for high-strength moderately alloyed steels extend far beyond the field of



Lukenweld, Inc.

Welded truck frames can be designed to be much lighter if made of low-alloy high-strength steels

bridge building. Examples of some of the diverse applications for these recently developed alloy steels include portable bridges, mobile artillery, semi-mobile or slow-moving equipment such as parts of power shovels, tractors, gantries, girder-type cranes, cement handling apparatus and similar equipment. The loss in power through the movement of useless dead weight is of sufficient importance to indicate the obvious advantage in weight savings. Perhaps the greatest use of these new steels is their application in the design of railroad equipment, since lightness of rolling stock not only saves in fuel but also in track maintenance. In addition to this, machinery that does not involve the element of mobility is nevertheless being lightened by using these moderately alloyed high-strength steels to serve the need for increased rigidity and more pleasing design.

High strength is not the only advantage of these new steels. For all practical purposes, they are as easy to fabricate as are the plain carbon steels. They can be welded with proper technique, and their ductility is comparable to that of plain carbon steel. But, from this it must not be inferred that when designing a structure to be made of these moderately alloyed steels, it is merely necessary to substitute the higher allowable working stress for that used for carbon steels.

In developing new designs that take full advantage of the higher tensile strength of the moderately alloyed steels and thus lighten the structure as much as possible, the designer must make certain that the required stiffness has been retained. As the modulus of elasticity is practically the same for all steel, it follows that for beam and column sections the moment of inertia must be the same for equal stiffness.

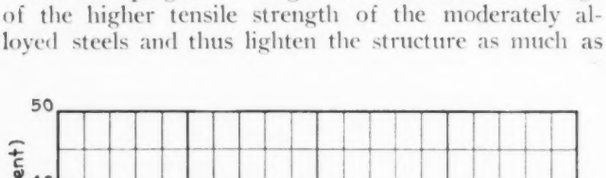


Fig. 1—Percentage saving in weight of columns made of high-strength steel as compared with columns made of plain carbon steel, as calculated by H. M. Priest

With reference to the allowable tensile stresses, in general, it may be stated that the higher the yield point the higher may be the tensile stresses, with the following fundamental restrictions:

1. The higher tensile steel must have sufficient ductility to meet the design requirements for ductility and shock resistance.

2. It must possess satisfactory notched bar impact values. That is, suitable "toughness" must not be sacrificed. It has been proved in tensile, bending and even in ballistic tests that the toughness of some moderately alloyed steels is not seriously depreciated with increased elastic ratios.

The design man must accumulate experience before he can use all the advantages of these steels.

In the development of the low-alloy steels, the primary aim was to increase the yield strength to well above that of carbon steel, without at the same time reducing the favorable characteristics mentioned above and also without reducing the formability any great amount. Formability in a sheet or plate may be defined in terms of the bending properties, as indicated by a bend or repeated bend test. In their report of a series of tests as published in *Metals Technology*, April, 1936, S. Epstein, J. H. Nead and J. W. Halley state that rather definite indications were obtained that the hardness or tensile strength, rather than the yield strength, limits the bend properties of low-alloy steels. That is, a steel with a higher yield point but lower tensile strength has better repeated bend properties than a steel with a lower yield point but higher tensile strength.

When it comes to the design of compression members which must resist bending, the benefit of increased tensile strength is no longer proportional beyond a limiting ratio of column length to radius of gyration. In the accompanying Fig. 1 are shown curves that compare the saving in column area through an increase in the yield point of the material for different values of L/r. It will be seen that beyond the value of L/r equal to 60 to 80, the curves rapidly approach each other, indicating that beyond that range of values for L/r there is little to be gained through an increased value of the yield point of the material. The criterion of column strength brings these values to the Euler value, or so-called Euler load, which is linked up with the modulus of elasticity.

A study of the column formulas readily shows why the advantage of a high yield point diminishes rapidly when the column ratio exceeds a certain range. These rationalized formulas for allowable unit compressive stress, contain the value of the yield point in the numerator, and the square root of Young's modulus of elasticity in the denominator. Since the latter is constant for practically all steels regardless of their composition or heat-treatment, the required value of allowable unit compressive stress will decrease rapidly with increasing values of L/r, beyond a certain point.

But for values below the critical ratio of L/r equal to approximately 60 to 80, the saving in metal required for a given design is obviously great for a steel possessing a higher yield point. Thus, for a maximum saving in metal the designer should select a column section that will give a maximum value of r and endeavor to decrease the value of L through the use of bracing or similar means. This later obviously has restrictions due to the weight added by the connections used to shorten L, the effective length.

As in the design of airplanes, thin corrugated sections can be used to obtain a relatively large value of r, the radius of gyration of the section. But care must be taken that such a formed sheet section will not become so thin that the column will fail by local buckling. (See the article "Light-weight Design with Shot-Welded Stainless Steel," July and August, 1934, *P. E.*) Similarly, in the design of beams, care must be taken that in the attempt to secure the maximum

Table I—Composition and Properties of Some Typical Moderately Alloyed Steels

	COMPOSITION									Yield Strength Lb./In.²	Tensile Strength Lb./In.²	Elong. in 8" %	Room Temp.	
	% C	% Si	% Mn	% P	% Cu	% Cr	% Ni	% Mo	% V				Izod. Ft.Lb.	Charpy
Ordinary	0.20	.....	0.40–0.60	0.04	0.20	.....	.....	.....	.....	25–30,000	50–60,000	25–30	.....	25–35
High Carbon	0.40–0.45	.....	0.40–0.60	0.04	.....	.....	.....	.....	.....	45,000	80–90,000	18–20	.....	15–20
Nickel	0.40–0.45	.....	.....	.....	.....	.....	3–25–3.50	.....	.....	50–60,000	85–100,000	18–20	40	.....
Mayari	0.40	.....	.....	.....	.....	0.50	1.25	.....	.....	50,000	85,000	19	.....	.....
Ni-Mn	0.30	0.30	1.0	.....	.....	.....	2–2.5	.....	.....	65,000	100,000	19	.....	.....
Yoloy	0.24	0.26	0.67	0.05	1.0	.....	2	.....	.....	60,000	88,000	27	.....	25
Hi-Steel	0.10	0.15	0.50	0.10	1.0	.....	0.50	.....	.....	55,000–65,000	75–85,000	22	.....	50
RDS**	0.23	.....	0.75	.....	1.3	.....	0.75	0.16	.....	70,000	90,000	20***	50	.....
Cor-Ten	0.10	0.50–1.0	0.10–to 0.30	0.10–0.20	0.30–0.50	0.50–1.50	.....	.....	.....	50–60,000	65–75,000	23	60	.....
A.W. 70–90	0.27	0.01	0.45	0.10	0.45	.....	.....	.....	.....	75,000	90,000	14–20	.....	.....
Cromansil	0.14	0.76	1.24	.....	**	0.47	.....	.....	.....	62,000	91,000	25	.....	.....
Man-Ten	0.23	0.23	1.40	.....	0.28	.....	.....	.....	.....	65–70,000	88–93,000	19–20	.....	.....
Jal-Ten Max.	0.35	0.30	1.25 to 1.75	.....	.40 min.	.....	.....	.....	.....	50,000	80,000	20	40	.....
Delaware River Bridge	0.31	0.29	0.96	.....	.....	.....	.....	.....	.....	52,500	90,500	25	.....	.....
Recent U. S. Navy	0.18	0.25	1.45	.....	0.20	.....	.....	.....	0.18	50,000	80,000	20	.....	.....
Sil-Ten	0.40	0.20–0.30	0.70–0.90	.....	0.20	.....	.....	.....	.....	45,000	80–95,000	24	.....	.....

Only a few of the many commercial analyses are shown here because of lack of space.
The tabulation indicates the scope of analyses and what range of physicals is now available.
**0.50 per cent copper may also be present.
***In 2 in.

strength and stiffness, that the thickness of the web and flanges is not diminished to a point where local buckling will occur.

In addition to the advantages of low-alloy steels as shown by the stress-strain diagram of the conventional tensile stress, there are also the advantages of better shock resistance, higher fatigue strength and frequently better corrosion resistance. Although the corrosion resistance of the moderately alloyed steels does not compare with that of steels in the higher brackets of alloy content, they are less liable to pitting. And while they do rust, they are free from that objectionable form of progressive deterioration which is evident in perforation. Therefore, in designing structures that are to be used outdoors, it may not be necessary to allow as much additional thickness to compensate for corrosion as is required when designing with plain carbon steels. The behavior of a specific steel with reference to corrosion may generally be obtained from the manufacturer. This fact will permit considerable weight saving especially where thin sections are used.

There is still much to be learned to permit the maximum exploitation of the moderately alloyed high-strength steels. And in the commercialization of these steels, it is necessary to coordinate the work of the metallurgist with that of the designer and producion man. Machining, punching, shearing, bending, flame cutting and welding properties must be coordinated with other desirable features. The cost element must be carefully worked out.

With reference to cost, it must be remembered that figures that are only a few months old may be entirely in error. The cost of a material depends largely upon the demand for it. Naturally, in the early development stages the demand will be relatively small. Cheapness, the reciprocal of cost, of any pioneering commodities is slow to increase at first. Even a small demand, however, stimulates production which in turn results in diminishing the cost of producing the material. The cheapness then rapidly increases, finally reaching a nominal value which is more or less static with the lapse of time, unless perchance, there is introduced some new contributing factor effecting a revolution of practice.

In a sense, the most important step forward will be taken through the medium of revision in design. Just as certain organizations have pioneered in the welding field by backing their engineering judgment with the construction of full-scale buildings, so will progress be made by the adoption of new design into machines and structures—at first on an experimental basis—where safety hazards will not be involved. One may therefore visualize a board or a group of recognized authorities agreeing on certain radical changes in the construction of several typical items as, for example, a light-weight freight car, a ship or a bridge, this followed by its erection and practical testing—if necessary well into the limit of its reserve safety. Such a design, if very radical, should be confined to a laboratory demonstration.

Because such a revision of design thought is necessary now in the interest of the conservation of both materials and energy, it affects the general welfare and thus transcends the interests of the manufacturers of any of the commodities involved. The makers and users of nearly all of our capital goods and far over into the consumer lines have a real and immediate stake in the modernizing of equipment. The problem is much larger than the individual interest of any one industry, since it involves the conservation of resources through the saving of material by lessening repairs to structures and apparatus, and the utilization of energy. Engineering groups, manufacturers and even the general public, therefore, have incentives to study the means of cooperating in the proper engineering of lighter constructions.

REFERENCES:

"Light-weight Design with Shot-Welded Stainless Steel," *P. E.*, July and Aug., 1934.

"Designing to Use Aluminum," George W. De Bell, *P. E.*, Feb., 1936.

"Thin Aluminum Alloy Sections," S. A. Kilpatrick and O. J. Schaefer, *P. E.*, Feb., March, April and May, 1936.

QUESTION AND COMMENT

Alignment Chart for Weight of Glass Tubing

To the Editor:

● I have read with interest the series on "How to Make Alignment Charts" which appeared in *Product Engineering* over the past nine months. We desire a chart to show the weight of a range of glass tubing the material having a specific gravity of 2.84. In the accompanying table, T = wall thickness and $O.D.$ = outside diameter. The last item, marked cane, is solid and is used as a reference point of zero wall thickness. Weights are given in grams per 48-in. lengths.

T in in.	*O.D. in in.*	*Weight in Grams per 48 in. length*
0.018	0.630	77
0.018	0.568	70
0.018	0.512	63
0.028	0.630	118
0.028	0.568	106
0.028	0.512	96
0.038	0.388	93.5
0.038	0.445	109
0.048	0.445	133
0.048	0.548	168
0.018	0.084	8.6
0.018	0.111	12.2
0.028	0.084	11.4
0.028	0.111	16.9
0.042	0.084	12.4 (cane)

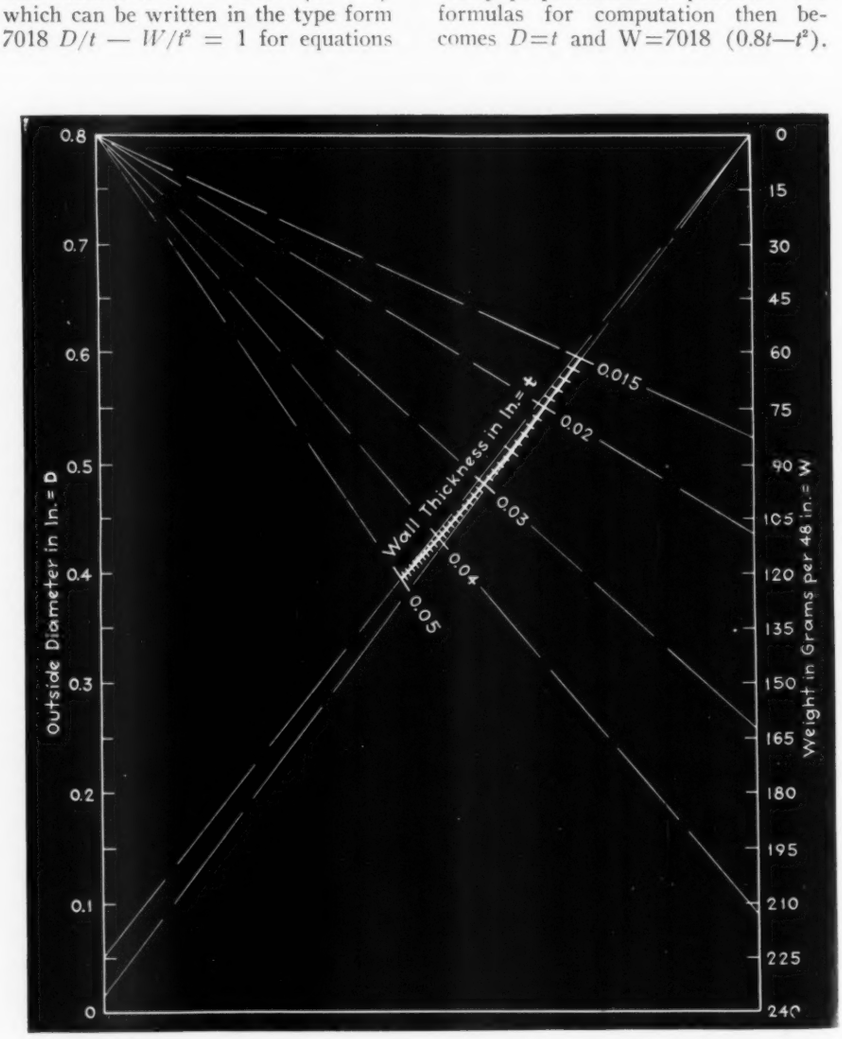
—H. K. RICHARDSON
Bloomfield, N. J.

To the Editor:

● When constructing a nomogram for weights of glass tubing from data given in the table above, it is necessary to know in what units the variables are to be used and between what limits. In other words, how large and small in diameter the tubing is that must be covered by the chart, and how thick and how thin the walls will be. This is determined in the form of a table indicating all of the sizes of tubes made and the units used. An unexpected characteristic in this instance is the use of the combination of grams and in. as units, for weight is measured in terms of grams per 48 in. length. It is therefore determined to use a constant specific gravity thereby reducing the number of variables in the equation to three.

With these facts known it is possible to shape up the equation into usable form. A handbook reference gives the formula as: $W=3.14\,p\,L\,t\,(D-t)$ in which W in the weight; p the specific gravity (2.84 in this instance); L the tube length; t the wall thickness; and D the outside diameter of the tube. Substituting for the constants: $W = 3.14 \times 2.84 \times 16.39 \times 48 \times t\,(D-t)$. The factor 16.39 reduces specific gravity from grams per c.c. to grams per cu.in. This equation then reduces to $W = 7018\,t\,(D-t)$ which can be written in the type form $7018\,D/t - W/t^2 = 1$ for equations having two functions of one of the variables.

Two parallel lines are uniformly divided with uniform scales of D and W ascending in opposite directions, the t scale being between the D and W scales. Such a nomogram is more satisfactory than when the D and W scales ascend in the same direction. Five values of t over its range (0.015, 0.02, 0.03, 0.04, 0.05) are selected to determine the t scale line. The formula $W=7018\ t\ (D-t)$ is then solved for these values of t for the two instances when $D=0.8$ and when $W=0$. These values are chosen for ease of computation and because the intersecting construction lines for locating points on the t scale are as nearly perpendicular as possible. The formulas for computation then becomes $D=t$ and $W=7018\ (0.8t-t^2)$.



Nomogram for determining the weights in grams of glass tubing of various outside diameters and wall thicknesses for 48 in. lengths

The first equation requires no computation, of course. Lines are simply drawn from $W = 0$ through the desired value of t on the D scale line. The intersection of one of these lines with another drawn from $D=0.8$ through the computed value of W for the same value of t, will give the scale division for that value of t on the t scale line.

A partial table of values of W and t is given as:

t	W	t	W
0.015	82.62	0.04	213.3
0.02	109.5	0.05	263.1
0.03	162.5		

These points determine the t scale line closely enough that the intermediate points can be located with only one equation, $W=7018\ (0.8\ t - t^2)$.

—M. G. VAN VOORHIS
Rocky River, Ohio

Gages Based on Preferred Numbers

J. I. HOMMEL
Westinghouse Electric & Manufacturing Company

●Wherever the inch is used as a measuring unit, there are a number of so-called gage systems which apply to thickness dimensions of sheet metals, the diameters of wires and rods, and the sizes of drills. Such systems are useful, for without them the variety of materials dimensions would be unlimited, resulting in an enormous accumulation of sizes, dies and stock. There are, however, two main objections to the gage system most generally used in the U. S. A. First, there are too many systems; one or two should be sufficient for all manufacturing needs. This multiplicity of gages is the cause of much confusion and error. When changing from one material to another, it often becomes necessary to change the thickness of the material because of the different basis of dimensions for two different materials. The U. S. Standards gage applies to sheet steel and to sheet iron, but the same gage number represents a value that is different for steel from that for iron. The difficulty is enhanced as there is no sharply defined dividing line between these two materials. To avoid possible errors many manufacturers have discontinued specifying sizes by gage numbers but instead give the decimal inch equivalent to such numbers.

Another important deficiency of the present system is their lack of a logical selection of progressive steps. In following the law of geometrical progression the difference between two successive numbers is a constant percentage of the smaller of the two numbers. This law was applied in the American Wire Gage System developed by J. R. Brown of the Brown & Sharpe Manufacturing Company in 1857. In this system the diameter of each succeeding number is found by multiplying the preceding number by 1.123, resulting in an increase of 12.3 per cent, starting with No. 36 wire or 0.005 in. as the basic size.

The AWG system could be greatly improved if instead of 12.3 per cent a smaller increase were chosen, such as is needed for establishing a standard line of twist drills. Such an ideal system is already available in the "Preferred Numbers" system, standardized by the American Standards Association. Numbers start with 1 and end in an exact multiple of 1. Where the 12 per cent increase represented by the so-called 20 series is too large, the 40 series or a 6 per cent increase may be used.

Tables of a proposed gage system based on Preferred Numbers have been prepared and are now being considered for final approval by the American Standards Association. They show the corresponding Preferred Numbers that could be used as a substitute for existing gage numbers, provided the designer is not limited by existing equipment, demand for interchangeability or available manufacturers' stock of materials. It is, of course, hardly to be expected that changes will be made precipitously at any one time, but with proper cooperation between manufacturers and users, changes may come about gradually, as stocks become exhausted or dies become obsolete, worn out, or broken in service.

The most commonly used systems and their principal applications are as follows:

SYMBOL	*NAME*	*APPLICATION*
AWG or B & S	American std. wire gage commonly known as Brown & Sharpe gage	Non-ferrous wire, sheet, and strap steel banding wire
BWG	Birmingham wire gage also known as Stubs' iron wire gage	Spring steel (narrow strips) Wall tks. of seamless tubing
Stl. WG or NWG	Steel wire gage also known as National, Roebling's or Washburn and Moen's wire gage	Steel wire except music wire and banding wire
USG	United States std. gage	Iron and steel sheet. The U. S. Std. gage iron values are used for both iron and steel sheet.
MWG	Music wire gage	Steel spring wire 0.090 diameter and less
TDG	Twist drill and steel wire gage	Steel twist drills
SWG	Stubs' steel wire gage	Steel drill rod

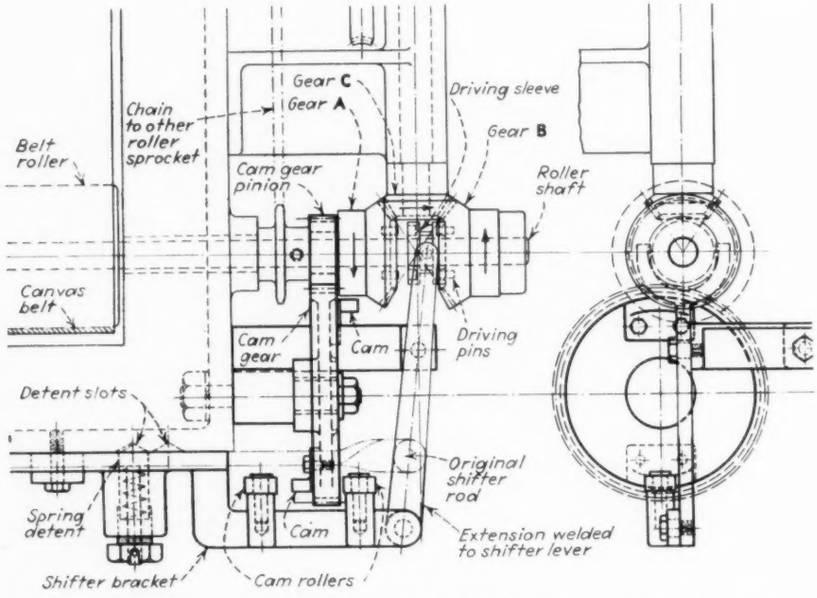
Automatic Reversal for Candy Machine

W. E. SUMMERHILL
Cleveland, Ohio

● Automatic reversal of the batch roller belt was desired on a certain manually-operated candy machine to allow the operator to handle the batch with both hands. In operation, the batch of candy rolls on a canvas belt running over rollers, the rotation of which must be reversed to keep the candy uniform. Previously, throwing a lever within the operator's reach shifted the driving sleeve from one bevel pinion to another thus reversing the rotation. To convert this into automatic reversing, the parts shown in the heavy full lines were made and attached. The hub of bevel gear A was turned down and the cam gear pinion pressed on and keyed to it. It rotates in the direction indicated. The cam gear runs on stud mounted in bed and has cams fastened to opposite sides of its web. As the cam gear rotates, the cams contact rollers on the shifter bracket causing it to move the driving sleeve from one

clutching position to the other.

The height of the cams is just enough to move the driving sleeve to a neutral position. At this instant the spring detent has passed over the crest between the two detent slots milled in the side of the bed. The spring forces the plunger down into the adjoining slot, and when the pins in the gear mesh with the holes in the driving sleeve, the drive is reversed. Gears *A* and *B* have a running fit on the shaft and rotate constantly, taking their drive from gear *C* mounted on a motor driven worm gear shaft.



For automatic reversal, cams shift driving sleeve to neutral at which time spring-loaded detent causes engagement of reversing clutches

Nitrided Gears

To the Editor:

●Regarding the request of J. I. S. for information on nitrided gears, in the June number of *Product Engineering* on page 2, the nitriding process calls for a special steel, the usual analysis being:

Carbon	0.30 - 0.40 per cent
Aluminum	0.90 - 1.40
Chromium	0.90 - 1.40
Molybdenum	0.15 - 0.25
Manganese	0.40 - 0.60
Silicon	0.20 - 0.30

The material should be heated and quenched in oil or water from 1,700 deg. to 1,750 deg. F., and tempered at 1,150 deg. to 1,350 deg. before machining, and then nitrided, the latter consisting of heating in a furnace with ammonia gas. When removed from the furnace and cooled the piece has a hard surface and is ready for use.

Briefly, one of the important advantages of nitriding is that low temperatures are used, with the result that warping and distorting are at a minimum, which is a decided advantage in gearing. —C. H. HUGHES

New Dorp, Staten Island, N. Y.

To the Editor:

●When nitriding such pieces as small gears, the procedure is to preheat the steel, rough machine, heat to nitriding temperature, machine to finish size, then nitride in a chamber through which a controlled stream of ammonia gas is passed. No quench is necessary. Nitriding temperature for small gears is about 900 deg. F., which is not high enough to affect previous heat-treatment. Nitralloy steel containing aluminum is best. —R. A. K.

Waban, Mass.

Are Elliptical Gears in Modern Use?

To the Editor:

● With reference to A. H. Shum's letter on page 313 in the August number, there are some modern machines equipped with elliptical gears. In the corrugated paper industry, with which the writer is specially acquainted, this type of gear has been used successfully for years. A most successful cut-off machine for corrugated paper board is equipped with elliptical gears and the probability is that their use will continue for many years to come.

This type of gear came into general disfavor because it could not be produced accurately and economically. However, with the present-day machine-shop methods, they are being manufactured relatively cheaply and with accuracy; and there is no doubt that, as the machine designer becomes more aware of their practical possibilities, they will find a much wider field of application than they have at present. Elliptical gears will then be no longer generally regarded as a mere mechanical curiosity, but as a practical means for obtaining certain useful motions.

—J. J. PESQUEIRA

New York, N. Y.

To the Editor:

●I agree with you that elliptical gearing is used in modern machine design. Little publicity, however, is given to the applications by the manufacturers of machines, but it is well known that the operating efficiency of such machines is often improved by the use of these gears.

When automatic control of a variable speed cycle (part working and part idle time) is required, elliptical gearing can be used to reduce the idle time and increase the working time. The constant rotating speed of the machine is converted, by the elliptical gearing, to a "fast-slow-fast" rotating speed and is referred to as a "quick return motion."

Four common uses are:

1. For conveyors, packaging, and bottling machinery in which the slow working stroke of a pusher is required to prevent breakage of merchandise and to minimize the loading table vibration, a fast return stroke being desirable to obtain maximum operating efficiency.

2. In spraying and discharge apparatus where a distribution to an elliptical area is often desirable.

3. For machine tools when a variation in the machining speed cycle is required as when machining spherical or curved surfaces.

4. On vibrating apparatus for a "shakedown" operation in the conveyance of empty containers to relieve them of residue, and in loaded containers for obtaining compact packaging.

When the center distances of the shafts are too great for gearing, elliptical sprockets are used in chain drives for the same purpose.

—RICHARD K. LEDUC

Wollaston, Mass.

[*Editor's Note:* The last sentence in the above comments regarding elliptical sprockets should be of interest to machine designers and we invite the submission of photographs and sketches of such applications.]

Bearings Wanted

To the Editor:

● As a suggestion to A. M. Holland's request for information on non-metallic, self-lubricated bearings, appearing in the August number, I would like to point out that laminated plastic bearings have been developed for certain rolling mills. Because of the severe service requirements for such application, involving pressures up to 1,500 lb. per sq.in., it was necessary to lubricate these bearings with water. However, for anti-friction characteristics in bearings, graphite filler has been introduced into some molded plastic materials with satisfactory results for less rigorous requirements than those stated. These graphite-plastic bearings have not been used extensively, and to the best of my knowledge the maximum surface speed such bearings can withstand has not yet been determined. —J. DELMONTE
Philadelphia, Pa.

Screw Back-Lash Adjustment

To the Editor:

● The requirements of Henry Martin as given on page 313 of the August number for a design of lead or feed screw nut in which the slack or wear can be taken up, are met in the design shown herewith. The 2-piece nut is made of bronze. The adjustable member, having a chucking piece cast on the knurled end, is faced, turned, knurled and cut off at the first setting. The stationary member of the nut is slotted at *A* and *B* for clamping purposes, drilled and tapped for the clamping screw, then chucked, faced and bored to a close wringing fit for the adjustable member. After the two pieces have been assembled, and secured with the clamping screw, they are bored and threaded as one piece, to fit the feed or lead screw. Surface *C*, for attachment to the machine, is then machined.

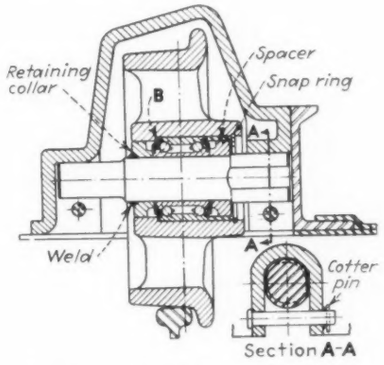
By turning the knurled part in the direction of the hand of the lead screw, looseness can be taken up and a snug fit maintained by tightening the clamping screw. This type of adjustable nut has been successfully used on some lathes and planers for several years. —M. H. BALL
Watervliet, N. Y.

Bearing Retainer Welded to Shaft

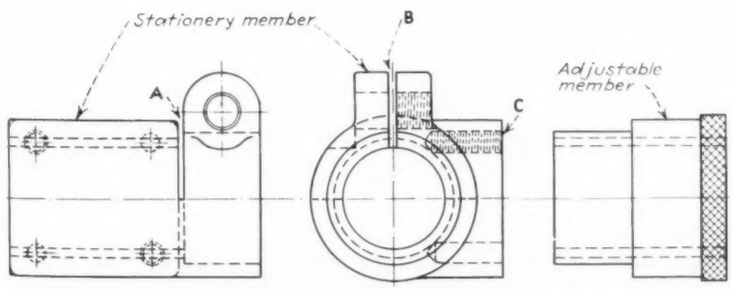
FRED ADAMS
New York, N. Y.

● To avoid threading the stub axle of a mine-car wheel for a lock nut to retain the ball-bearing, the method illustrated shows the retaining collar welded in place. Two identical collars are pressed on the shaft, with the ball bearing between them, the outer collar or bearing retainer being welded as shown. After the wheel has been slipped over the assembled shaft and the bearing is shouldered at *B*, a spacer and snap ring are assembled into the wheel hub.

Should it become necessary to replace the bearing, the welded portion can be counterbored in a lathe to free the retaining collar from the shaft. Because the bearing is pre-lubricated and sealed, no further lubrication is required. The largest diameter of the axle is milled flat as shown in section *A-A*, to prevent turning in the wheel housing.



Welding simplifies machining operations on axle for mine-car wheel, one wide-race, double-row ball bearing being used, pre-lubricated and sealed

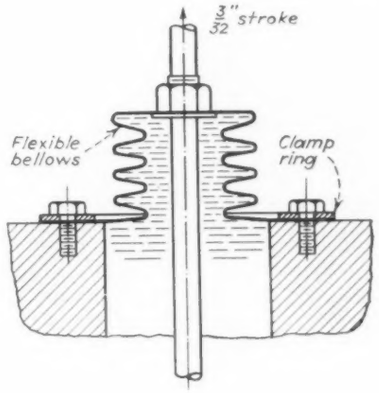


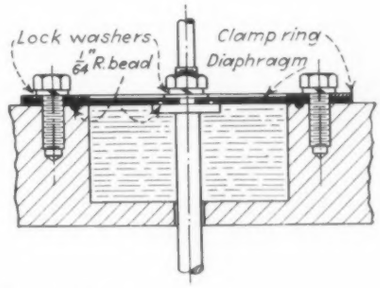
Adjustable nut for lead or feed screws made in two pieces and then bored and threaded as one piece

100 Per Cent Seal Required

To the Editor:

● The accompanying sketch shows a method of obtaining a 100 per cent seal as required by S. P. Lee on page 313 of the August issue. A flexible bellows is attached to the frame with a clamping ring, and to the rod in a conventional manner. A sufficient number of convolutions of the bellows absorb the 3/32 in. movement.
—W. H. KOHLER
Denver, Colo.





To the Editor:

● In reply to S. P. Lee for a 100 per cent seal, the accompanying drawing illustrates a synthetic rubber disk used as the diaphragm. A small bead with 1/64 radius is turned on the flange of the reciprocating stud, over which the diaphragm is compressed by the plain washer, lock washer and nut. A small groove with a similar radius is machined in the casting, the groove filling up with the diaphragm material when compressed with the clamping ring and screws. This gives an oil tight joint at both surfaces.
—SALVATORE GANGI
Brooklyn, N. Y.

Errata

● In the article "Stresses and Deflections in Flat Plates" on page 252 of the August number, under the heading "Notations" the reciprocal of Poisson's ratio should be *m* and not *M* as shown.

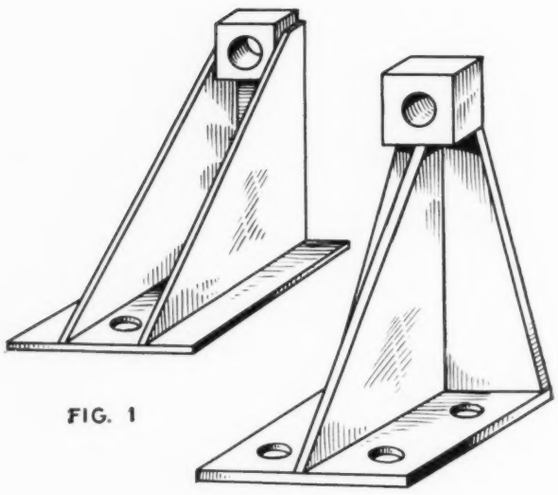


FIG. 1

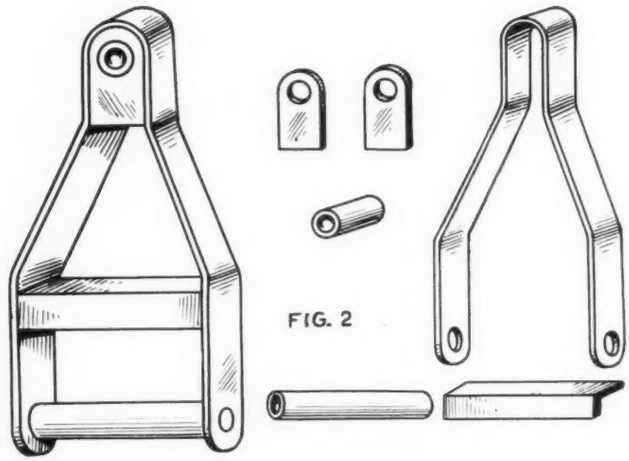
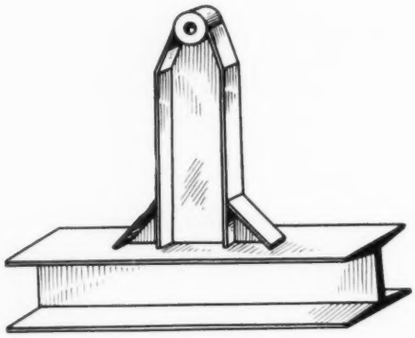


FIG. 2

Typical Welded Bases

The purpose of the welded constructions shown here is to indicate types of designs rather than recommended finished products



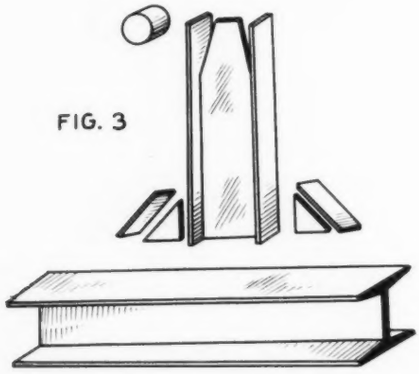


FIG. 3

Fig. 1—Two forms of brackets for an adjusting screw, using only straight cuts on the plates. Appearance, as in all designs shown here, can be improved by rounding the corners and curving the edges.

Fig. 2—Welded connector, made of a bent flat and standard shapes, for two shafts perpendicular to each other. Pipes, later to be bushed or babbitted, serve for the bearings.

Fig. 3—Bearing support for special equipment, made entirely from stock parts requiring only square cuts. A short piece of drilled round bar is used in place of the square block used in Fig. 1.

(The Lincoln Electric Company)

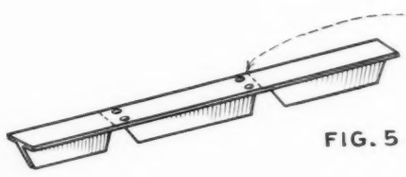
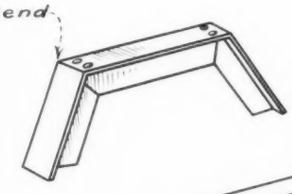
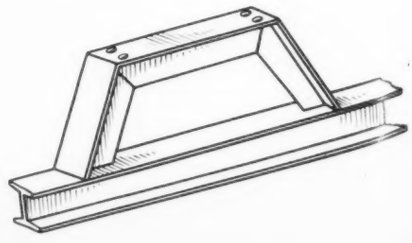


FIG. 5





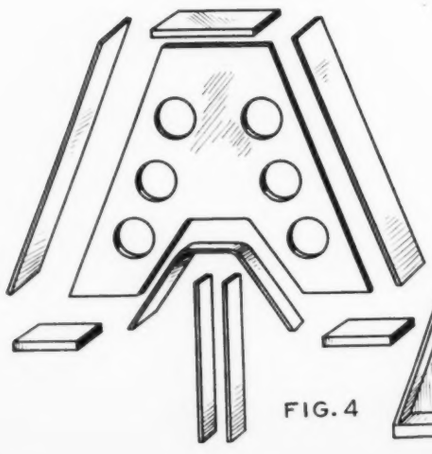
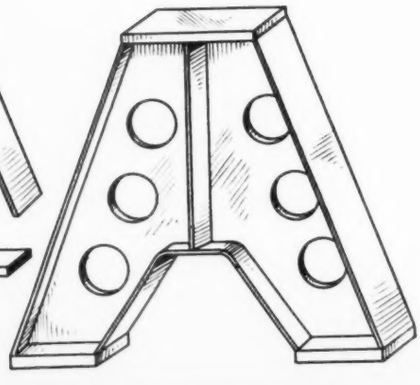


FIG. 4



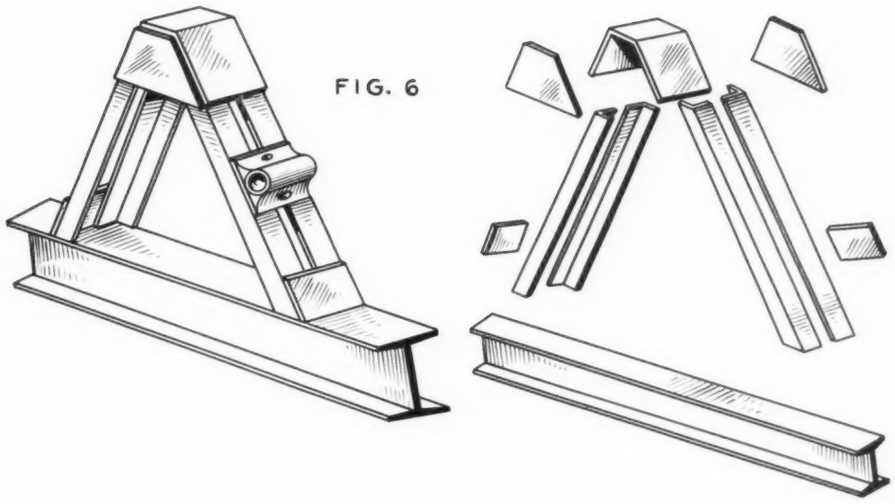
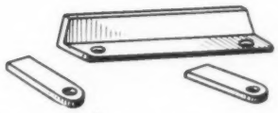


FIG. 6

and Pedestals-I



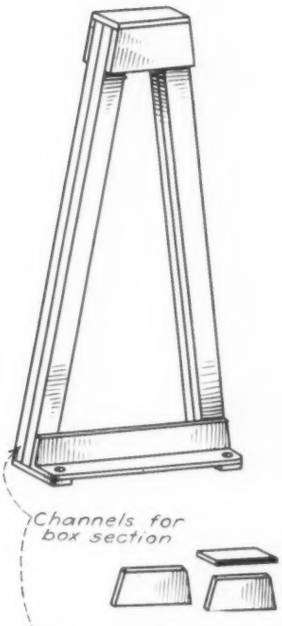


FIG. 7

Fig. 4—Supporting base made entirely of flat plates welded together. The lightening holes and coping in the web plate serve primarily to improve the appearance.

Fig. 5—Inexpensive bearing support suitable for other than extreme loads, using either a T-bar or a split I-beam for the upper section.

Fig. 6—Design of support wherein the slot between the angles permits adjustment of the bearing position. T-head bolts are used for holding the bearing.

Fig. 7—Two channels make a box section for each column of this bearing support. For appreciable thrust loads, a wide base plate would be used in place of the two narrow feet.

Fig. 8—For heavy loads an assembly of I-beams can be used, the I-beam webs being split to make T-bars.

Fig. 9—For a bearing support of medium height it may not be feasible to use an I-beam. Two flat and one bent plate will achieve the same purpose. The pipes add strength and rigidity and also serve as guide holes for the holding-down bolts.

(*The Lincoln Electric Company*)

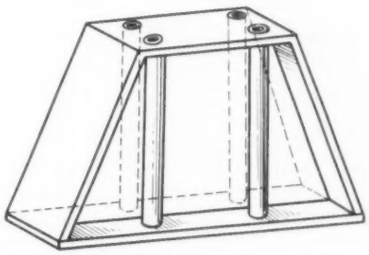


FIG. 9

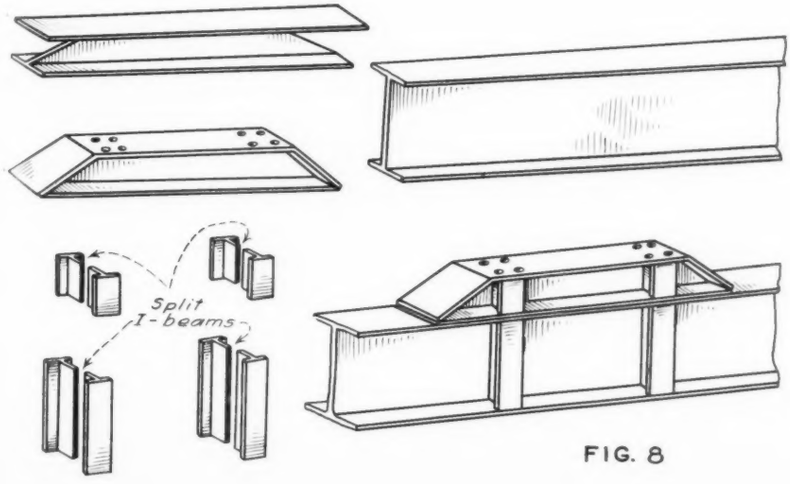
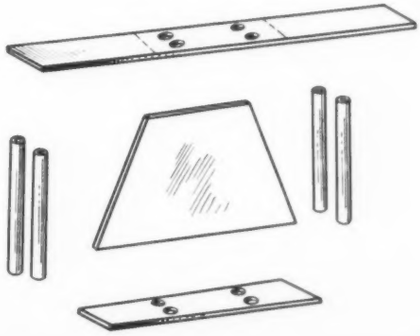


FIG. 8



NEWS

A.G.M.A. Meeting Papers Discuss Gear Noises, Gear Units and Hypoids

WHY rigid engineering design specifications and acceptance inspection should be the basis for gear purchases, was forcibly brought out in a paper by W. P. Schmitter of the Falk Corporation, presented at the nineteenth semi-annual meeting of the American Gear Manufacturers' Association. In his discussion of "Quiet High Speed Gearing," Mr. Schmitter first gave some striking examples wherein gear noises were the cause of serious complaints, and then explained the causes of such noises.

Faulty gear operation, he explained, may result from influences over which the gear designer has control, over which the shop has control, or which can be controlled only by the designer of the machine on which the gears are to be used. Fifteen separate causes of gear noises are enumerated and ten essentials for quiet operation of herringbone gears are listed.

For quiet running high speed gears, the teeth must be cut accurately, lapped and then polished; the gear must be made of a high quality material and must be balanced dynamically after it has been machined. Proper heat-treatment is another cost item for refined high-speed gears. Hence the absurdity of purchasing such gears solely on a price basis.

In his paper "Relations Between Load Rating and Design Stresses of Gear Units," C. B. Connell of the Westinghouse Electric and Manufacturing Company analyzed the stresses in gears, shafts and bearings of speed reducer units. Although in some cases the load rating may be based on the thermal capacity, in most cases the load rating is based on the mechanical strength.

Any speed reducer having the A.G.M.A. nameplate is designed to safe working stresses, which contain an inbuilt service factor, to deliver a uniform flow of power as measured by the rating of the speed reducer with occasional and momentary overloads of 100 per cent. Any deviation from this requires the use of an application factor, namely a factor by which the normal actual power load must be multiplied to give the catalog rating required. A table of these factors is included in the paper.

Conditions to be considered in the selection of a speed reducer include impact loads, surges, unbalanced overhung loads, reversing service, type of coupling, type of drive and similar factors.

The type of coupling employed between the prime mover and speed reducer and between the speed reducer and driven equipment is a more important factor than is generally recognized. The couplings should compensate for the usual shaft misalignment, allow lateral end-float and protect the driving equipment from excessive shock. These items and an analysis of types of couplings are taken up in detail by the author.

In the last portion of the paper is briefly reviewed the characteristics of different types of motors and their effect on the speed reducer.

A third paper delivered at this A.G.M.A. meeting pointed out the possibilities in the use of hypoid gears. Written by A. A. Candee of the Gleason Works, the paper showed how different shaft arrangements, not possible with conventional type gears, can be used with hypoids. Other types of gears discussed by Mr. Candee included the formate gear, made by a non-generating process, and the spiral bevel gear with zero spiral angle.

All sessions at this semi-annual meeting were held on the Great Lakes steamer Sceandbee on a slow trip from Chicago to Cleveland. About 125 members and guests were present.

Steam-Electric Loco to Have Condensers

ANOTHER page in the rapidly accelerated history of modern railroading will be turned early next year when the General Electric Company delivers the new steam-electric locomotive which it is now building for the Union Pacific Railroad.

Designed for passenger train service, the locomotive will carry a condensing steam turbine generating plant feeding electric power to traction motors. Radically different in design from any locomotive now in service—of either steam or electric type—it will eliminate two of the colorful characteristics of the steam-railroading days—the side-rod drive and the water tower. Electric power will drive traction motors constructed on the usual electric locomotive design, and the turbine will operate condensers using the same water over and over, with small additions to make up for leakage. The problem of picking up water is thus largely done away with.

The new unit will be a double-cab locomotive, rated at 5,000 hp. The two cabs can be operated together in the same manner as with electric locomotives. It will haul 1,000-ton trains such as the Union-Pacific "Challenger" or the Los Angeles Limited over the Los Angeles-Omaha route.

Streamlined, practically smokeless, and provided with equipment for air conditioning, the new locomotive will be modern in every respect. The builders promise speeds of 110 mi. per hr. on level track. As with the electric locomotive, a finely graduated scheme of control will permit smooth and easy handling, rapid acceleration, and effective braking.

A new, highly efficient type of oil-fired steam boiler has been built, and tests give ample assurance of power to meet the exacting requirements of the locomotive. The high steam pressure and use of condensers are in line with the latest practice in modern power plant construction.

Auto Show to Set New Records

WITH every prospect of being one of the most important and interesting exhibitions of its kind, the National Automobile Show will open in Grand Central Palace, New York, on Armistice Day, Wednesday, Nov. 11. Plans indicate that the slogan of the show—"The Pacemaker for American Industry"—will be supported by a greatly augmented exhibition with numerous new attractions for the public and the trade.

To accommodate the extraordinary demand for trailer exhibits on extra floor, suitably decorated to represent a trailer camp, is required. Some fifteen trailer manufacturers will display their products, along with the

accessories and equipment that go with this new mobile home-on-wheels for modern nomads.

Last year's November launching of new models proved so successful in stimulating automobile buying as well as stabilizing labor conditions that the industry is holding the formal introduction of its forthcoming new models during the same period.

For the first time in history, the exhibition will open in the middle of the week—on Wednesday instead of Saturday, as in the past, and will run through the following Wednesday.

Wins Prize for Color Article

THE October issue of *Reader's Digest* will announce the names of the winners of their contest for the best articles on color. Readers of *Product Engineering* will be interested to know that among the first ten of the winners is Howard Ketcham. He will be remembered by many as the author of the series of articles on color that appeared in *Product Engineering* about a year ago.

In notifying Mr. Ketcham that he had won the award, the editor of the *Reader's Digest* wrote: "We are pleased to tell you that your article 'Color Scheme' is one of those adjudged most interesting by the *Reader's Digest* standards and is therefore declared winner of an award of $1,000."

The article may be published first in some one of the magazines cooperating with the *Reader's Digest*, or it may be condensed for original publication in the *Digest*. Date of publication has not been announced.

A.S.M.E. Meeting on Corrosion

A REMARKABLE symposium on Corrosion-Resistant Metals in Design of Machinery and Equipment will be held as part of the American Society of Mechanical Engineers' annual meeting in New York City, Nov. 30 to Dec. 4. The information presented is to be in compact form, of a practical nature, free from lengthy theoretical discussions but still sufficiently complete that when the different papers are assembled they will form a handy reference for the engineer of the subject of corrosion-resistant metals.

The need for such a symposium was expressed by designing and operating engineers of the country who are constantly confronted with many problems on corrosion. They are busy men and not many of them have been able to follow closely the rapid development of this type of information during the past few years. Several of the professional divisions of the society joined in developing the symposium making it a feature of the A.S.M.E. annual meeting where it has been alloted the whole day of Thursday, Dec. 3 with three sessions in the morning, afternoon and evening. T. H. Wickenden, past chairman of the society's Iron and Steel Division was appointed Chairman of the Committee that is arranging the symposium.

The papers to be presented are as follows: "Introduction to Corrosion Resisting Metals," Dr. F. N. Speller, National Tube Company; "Alloys of Aluminum," E. H. Dix, Jr., Aluminum Company of America; "Nickel and Nickel-base Alloys," F. L. LaQue, The International Nickel Co., Inc.; "Zinc in the Chemical Industries," E. A. Anderson, The New Jersey Zinc Company; "Lead," G. O. Hiers, National Lead Company; "Cast Iron in Chemical Equipment," Dr. H. L. Maxwell, E. I. du Pont de Nemours Company, Inc.; "Copper and Copper-base Alloys," R. A. Wilkins, Revere Copper and Brass, Inc.; "Corrosion Resistant Stainless Type Steels," J. H. Critchett, Union Carbide and Carbon Research Laboratories, Inc.

MEETINGS

International Acetylene Association—37th Annual convention. Nov 18–20, Jefferson Hotel, St. Louis, Mo. International Acetylene Association, 30 East 42 St., New York.

American Society of Mechanical Engineers — Annual meeting, Nov. 30–Dec. 4. C. E. Davies, Sec'y, 29 West 39th St., New York, N. Y.

EXHIBITIONS

National Business Show—Exhibition of office equipment, Commerce Hall, Port Authority Building, New York. Oct. 19–24. Frank E. Tupper, 50 Church St., New York.

National Metals Congress & Exposition — 1936 Annual meeting, Cleveland, Ohio, Oct. 19–23. W. H. Eisenman, secretary, 7016 Euclid Ave., Cleveland Ohio. The following national societies will participate: American Welding Society, the Wire Association, the Institute of Metals, the American Society for Metals, the American Institute of Mining & Metallurgical Engineers, and the American Society of Mechanical Engineers.

Power Show Opens November 30

THE management of the National Exposition of Power and Mechanical Engineering have announced that the 12th Exposition will be held from Nov. 30 to Dec. 5 inclusive, co-incidental with the annual meeting of the American Society of Mechanical Engineers.

The exposition this year is expected to be more comprehensive than in the past. The improvement in business will be one influence, and the great interest which manufacturers have aroused through research developing new products and improvements on standard products will make the exposition very interesting. There will be displayed a range of equipment ranging from that used in the generation of power, its distribution and utilization through mechanical equipment for handling materials, tools and various other mechanical devices. There will be the usual large grouping of refractories, stokers, burners and fuel burning equipment of various types, boilers and power generating equipment, engines, pumps and steam equipment, piping, valves, fittings, showing all the recent developments in these lines, and supplies used coincidental thereto, instruments of precision for control and measurement of volume, speed, rate of flow, pressure, time and other numerous factors which must be known in industrial operations.

It is reported that more than 100 of the former exhibitors have already reserved space and applications are being received daily.

Do You Know That—

• If all the pieces of wire in one foot of a certain type of high-pressure hose were laid end to end, the length would be more than one-fifth of a mile. (30)

• The textile industry uses stainless steel ball and roller bearings for equipment which actually runs under water. (31)

• Bread kept in refrigerated storage remains fresh much longer. Hence one baking company uses cork insulated trucks. (32)

• Machines are now available for flame-cutting a number of pieces simultaneously to the same shape. Multiple spot welding is another new development. (33)

(For details, write the editor, giving the item number.)

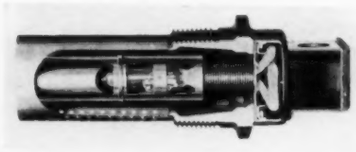
New Materials and Parts

Thermometer Tubing

Defines mercury column sharply. Used for mercury-in-glass industrial thermometers. Has wide angle of vision combined with high magnification of mercury column, and is readable at a distance. Triple-lens construction gathers three times as much light and concentrates it behind the mercury column in sharp relief against an extended opaque background. Known as BINOC it is available in thermometers of straight, angle and handled forms. Taylor Instrument Companies, Rochester, N. Y.

Fluid Level Control

Consists of a mercury switch inside a float attached to a flexible metallic bellows. Is screwed into a tank or boiler shell at a desired height. When liquid level changes the float moves through an arc to make or break contact to sound an alarm or to start or stop pump motor. Float is of seamless construction with a sealed bellows-head, and is protected with shield. Made for steam pressures up to 15 lb. per sq. in. with electrical ratings of ¾ hp. for a.c. 110-220 volts and ¼ hp. for a.c. 115-230 volts. Can installed in a 2½ in. pipe threadbe tapping. McDonnell & Miller, Wrigley Bldg., Chicago, Ill.



Drafting Machine

Equipped with an adjustable brake mechanism to prevent the protractor head from sliding when used on inclined board. Has adjustable skid buttons for leveling the scales. Equipped with precision, fully inclosed ball bearings lubricated for life. All parts are of dull-finish aluminum or baked enamel to eliminate reflection. The Standard model is designed for mechanical, architectural, and structural drafting. Charles Bruning Co., Inc., 102 Reade St., New York, N. Y.

Wire Rope Fittings

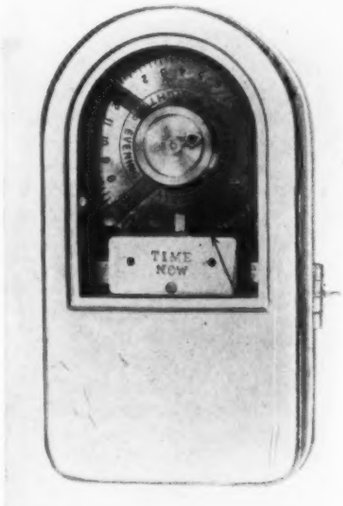
Eliminate the assembly operation of filling with hot metal. Cable ends are held by bending them over or passing them through a tapered metal plug inclosed in a drop forged steel body. It is claimed that the wire is not weakened with this type of grip. Available in open, eye, and stud end socket styles, also in turn-buckle assemblies, from ¼ to 1 in. sizes. Electroline Co., 4121 S. LaSalle St., Chicago, Ill.

Metallographic Outfit

Consists of inverted microscope units, illuminating system, 8x10 in. camera, supporting bed, stand, cabinet and stool. Has a 6 in. dia. revolving stage with graduated circumference. A vertical illuminator serves for bright field work and as an analyzer and polarizer for polarized light work. The dark field illuminator is a glass cube with central stop mounted in a rotating turret with the vertical illuminator prism. A photomicrographic lamp, used with a transformer gives an intensity said to be two and a half times that of any existing concentrated light source. Bausch & Lomb Optical Co., Rochester, N. Y.

Control Clock

Operates without winding or regulating, may be set on variable schedules. For the daily automatic control of electrical circuits. Non-magnetic housing prevents distortion of magnetic currents. Gears run in a sealed oil chamber. Device is made of non-corrosive materials, has 5,000 watts capacity, either single or double pole service, and is housed in a cadmium-plated case with unbreakable window. Tork Clock Co., Mount Vernon, N. Y.



Projector Lamp

Uses V-shaped coiled filament to obtain concentrated light source. Expressly for use in toy movie projectors. It is a 75 watt clear-bulb Mazda, bulb size A-17, and gives a more concentrated screen illumination than the old 100 watt lamp made for this purpose. Light center length of new lamp is 2½ in. Has a medium screw base and is designed to operate base down only on a range of 105 to 120 volts. Westinghouse Lamp Co., Bloomfield, N. J.

Bonderite "Z" Process

Converts the metal's smooth surface into an absorbent crystalline structure and produces an insoluble phosphate salt coating integral with the metal. Prevents corrosion and holds paint on zinc die-castings and galvanized iron. Can be applied to parts of any size or shape. Requires no electric current and is applied at low temperatures. Parts to be treated are cleaned, immersed in the processing tank one-half to three minutes, removed, rinsed and dried. Bonderite "Z" comes in concentrated liquid form requiring only addition of water to prepare the working solution. Parker Rust-Proof Co., Detroit, Mich.

Plating Solution Control

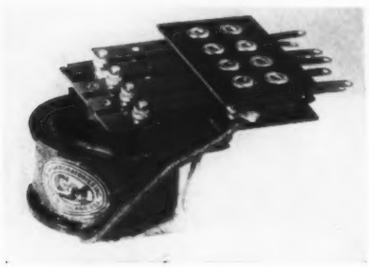
Three test kits have been developed providing a reliable and quick means for the determination of: cadmium in cadmium-cyanide plating solutions, zinc in alkali-cyanide or acid-zinc plating solutions, and total sodium-cyanide content in zinc or cadmium plating solutions. Designed to assist the plater in keeping the plating bath in the most efficient condition, and to apply a specified coating thickness in minimum time. Grasselli Chemical Co., 625 Euclid Ave., Cleveland, Ohio.

Heat-Resistant Plastic

For moldings which must retain their dielectric strength without carbonization under relatively high heat. Suitable for electric iron handles, heater and appliance plugs. It is stated that temperatures up to 450 deg. F. will not affect it when molded, that it preforms well, molds almost as fast as standard materials, has good arc resisting properties and low water absorption rate. Known as No. 34 and 37, is available in black and brown. General Plastics, Inc., North Tonawanda, N. Y.

A. C. Relay

Operates on the solenoid principle and is intended for "On-Off" use. The magnetic circuit is of iron. Coil is wound on a molded plastic spool. The control contacts are mounted on



spring blades. For quiet operation the plunger is provided with a shading coil. Can be installed on a vertical panel, or by using an additional bracket on a horizontal mounting surface. Available in types for 50-60 cycle and 25-30 cycle a.c. current. G-M Laboratories, Inc., 1731-35 Belmont Ave., Chicago, Ill.

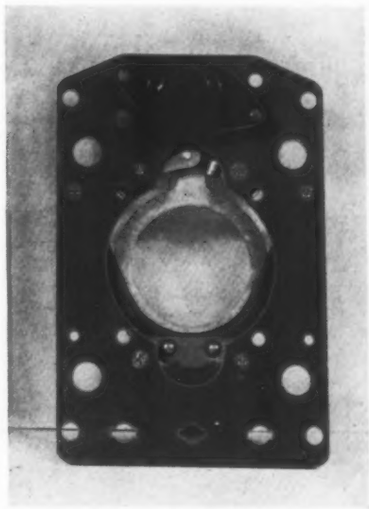
Sound-Level Meter

Measures noise quantitatively to meet new standards. Suitable for use near electrical machinery where stray magnetic fields are common. The microphone is of the non-directive piezo electric type. The five-stage amplifier is resistance-transformer coupled and has special small-size low-drain tubes. Meter is calibrated to read in decibels above the standard reference level of 10-16 watts per sq. cm. at 100 cycles, with a range of 30 to 120 decibels. Means are provided for using with an analyzer or a vibration velocity unit.

Complete instrument with tripod and batteries is contained in a metal case 15¾x9½x8¼ in. and weighs 39 lb. approximately. General Electric Co., Schenectady, N. Y.

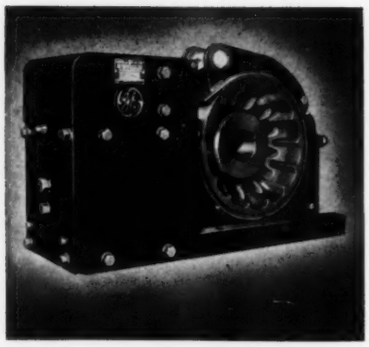
Thermal Release Switch

Provides motors with inherent overheating protection. Keeps motor on the line regardless of load as long as heat will not cause damage. In the construction used, internal heat is picked up by a thermal bar and transferred to a fusible alloy in a solder pot. Melting the alloy allows a cam assembly to rotate thus breaking contacts in the line circuit. Resetting is done by hand, and circuit can not be closed while solder is in a molten state. Line circuit is broken at 103 to 110 deg. C. Used on motors in ratings of ⅛ to 1 hp. and appliances which stop and start automatically. The Leland Electric Co., Dayton, Ohio.



Three-Shoe Brake

Actuating mechanism uses a clapper-type magnet. Intended for use with steel-mill machinery, cranes, hoists, and where it is necessary to stop and hold a load at the motor armature. Length of brake lining is 85 per cent of the wheel periphery which also gives greater protection



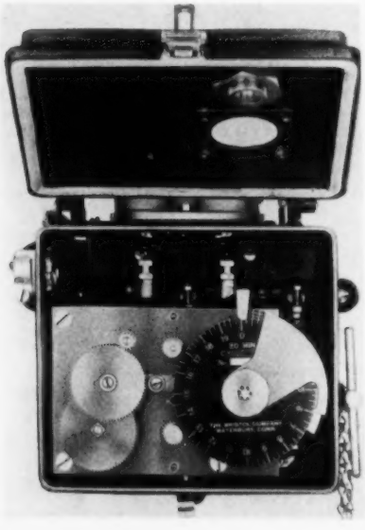
against dirt. Braking is equal in both directions of rotation. Frame is welded up of bar and plate steel. General Electric Co., Schenectady, N. Y.

Impregnating Resins

Eliminate the shrinking and swelling due to moisture absorption of wood and cellulose, and give greater resistance to solvents, acids and alkalies, and increase impact strength of surface. Articles treated with these new resins are pulp seats, wood knife handles, gaskets, clutch disks, golf club heads, and baseball bats. The resins are supplied in solution form. General Plastics, Inc., North Tonawanda, N. Y.

Cycle Controller

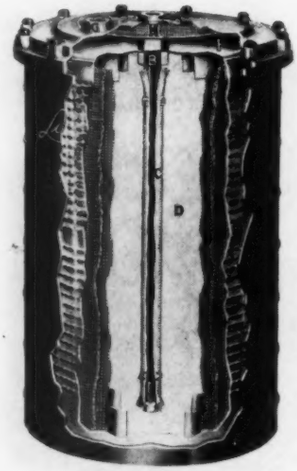
Two-speed cam operating mechanism makes possible a multiplicity of speed combinations. Suitable for controlling the high and low pressure molding operations with rubber and plastics where a variable speed is demanded by different jobs. Cam is adjustable for time cycle and operates one or two three-way pilot valves. The pilot valves control the flow of compressed air to diaphragm valves.



The device uses no gear shifts, governors, springs, or escapements. Known as Model 6088 V. The Bristol Co., Waterbury, Conn.

Oil Refiner

Is said to completely refine crankcase oil while engine is running. Used oil under pressure enters at top and flows through a central perforated tube which is covered with a fibrous material, then through a refining material contained in a perforated cylinder into an outer cylindrical space, then upward through a screen to an outlet opening and thence back to the crankcase. Can be installed on any internal combustion engine. Available in two sizes, one for crankcase capacities up to 7 qts., the other for 7 to 12 qts. capacities. Luberfiner, Inc., 1119 S. Hope St., Los Angeles, Cal.



High Strength Castings

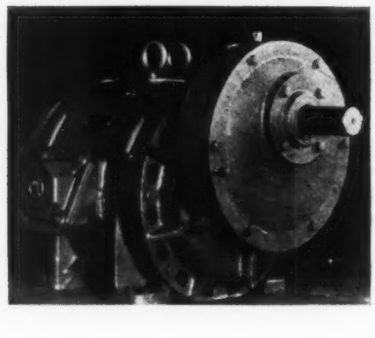
A copper-base alloy with small additions of cobalt beryllium. High strength and hardness are obtained by heat-treatment after casting. The castings have high electrical thermal conductivity. The properties for standard test bars are: electrical conductivity, 50 per cent; tensile strength, 95,000 lb. per sq. in.; elastic limit, 85,000 lb. per sq. in.; elongation in 2 inches, 5 to 8 per cent; hardness, 96-98 Rockwell B. Available only in the form of heat-treated castings. Beryllium Corporation of Pennsylvania, Reading, Pa.

Out-of-Step Relay

Prevents continued operation of synchronous machines out of synchronism with their connected system. Consists of instantaneous overcurrent and single-phase power-directional units, an auxiliary to increase operating speed, and a notching device with a time-delay element for resetting. A target is provided for visual indication after operation and is reset manually. Contacts are automatically reset after a time-delay. Mounted in a standard 5½x16 in. universal case. General Electric Co., Schenectady, New York.

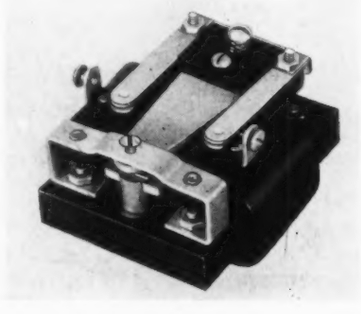
Explosion-Proof Gearmotors

For application in Class 1, Group D hazardous locations where speed reduction is required. Gears are of the single helical type. Fitted with anti-friction bearings. Approved for use in atmospheres containing gasoline vapors, also in varnish and pyroxylin plastic manufacturing plants, spray painting establishments and gas plants. Available in sizes from 1½ to 75 hp. Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.



Relay Transformer

Combines a low-voltage transformer and a line-voltage relay in a single device. Suitable for operating line-voltage equipment with a low-voltage control device. Three point armature contact and two milled knife edges with proper phase splitting is said to eliminate a.c. hum. Single-pole double-break silver contacts have wiping action. Rated at ½ hp. or 15 amps., a.c., 110 volts, 50 or 60 cycles. Size 3x3¼x2½ in.; can be attached direct to metal case. Russell Electric Co., 340 W. Huron St., Chicago, Ill.



MANUFACTURERS' PUBLICATIONS

A. C. Motors—The Lincoln Electric Co., Cleveland, Ohio. Folder, 6 pages, 8 x 10½ in. Describes features of squirrel cage induction motors for general purpose installations with tables of power ratings and dimensions.

Arc Welded Design Chart—The Lincoln Electric Co., Cleveland, Ohio. Wall chart, 24 x 35½ in. Presents in ready-reference form data for welded design, including weld symbols for working drawings, illustrations of 16 types of joints, weld dimensions and nomenclature, electrode metals, and allowable shear loads. Printed so as to be suitable for blueprinting.

Aluminum for Truck Body Construction—Aluminum Company of America, Pittsburgh, Pa. Bulletin, 28 pages, 8½x11 in. Recommends alloys for various applications. Illustrated with full-sized dimensioned sections showing shapes available.

Ball Bearings and Pillow Blocks—Ahlberg Bearing Co., 321 East 29th Street, Chicago, Ill. Loose-leaf catalog, 48 pages, 8½x11 in. Contains engineering specifications on new pillow block bearings, also data on the company's line of ball bearings.

Bearings for Paper Drying Machines—SKF Industries, Inc., Front St. and Erie Ave., Philadelphia, Pa. Bulletin, 10 pages, 8½x11 in. Illustrates and describes the application of spherical rolling bearing to the dryer section of paper machines. Contains line cuts showing method of mounting and construction. Advantages and new features are described.

Bearing Units and Applications—Medart Co., 3500 DeKalb St., St. Louis, Mo. Catalog No. 75, 22 pages, 8½x11 in. Describes types of Medart-Timken bearing unit mounts, also as installed in pillow blocks, hangers, and special designs. Ratings, specifications, and dimensions are included.

Beryllium Copper Castings—Beryllium Corporation of Pennsylvania, Reading, Pa. Folder, 4 pages, 8½x11 in. Announcing the alloys, uses and properties of beryllium copper heat treated sand castings now available. Illustrated with hardness charts.

Bolts, Nuts, Screws and Washers—H. M. Harper Co., 2620 Fletcher St., Chicago, Ill. Catalog and Price List, 48 pages, 5½x8½ in. Tabled data covering bolts, nuts, screws and washers made from corrosion and acid-resistant materials. Illustrated in colors.

Cold Rolled Strip Steel—Thomas Steel Co., Warren, Ohio. Handbook, 72 pages, 4x8 in. Contains quick reference information and data, with descriptions of tempers, edges, finishes, and coatings. Tolerances, gage equivalents and weights are tabled.

Colmonoy Alloys and Overlay Metals—Colmonoy Co., Los Nietos, Calif. Bulletin, No. 50, 16 pages, 3¾ x 9 in. Describes characteristics, methods of application, and available forms of a crystalline mixture which when alloyed with a base metal is said to impart wear, corrosion, and heat-resistant qualities.

Conveyor Chains—Link-Belt Co., 519 N. Holmes Ave., Indianapolis, Ind. Catalog No. 1552, 16 pages, 8½ x 11 in. Sets forth in illustrations, cuts, and tables, engineering data and dimensions covering plain and roller conveyor chain with attached links, also roller chain sprocket wheels.

Dipping Baskets—C. O. Jelliff Mfg. Corp., Southport, Conn. Folder, 6 pages, 8½x11 in. Covers a line of standard and special dipping baskets used in cleaning and pickling. Made in a variety of metals to suit customers' needs.

Effect of Molybdenum on Gray Iron Properties—Climax Molybdenum Co., 500 Fifth Ave., New York, N. Y. Bulletin, 8 pages, 8½x11 in. Describes the effects of molybdenum on the properties of cast irons of different base analysis. Tables are given of analyses and physical properties. Illustrated with photomicrographs and pictures of fractures.

Flexible Couplings—Diamond Chain & Mfg. Co., Indianapolis, Ind. Bulletin No. 12, 8 pages, 8½x11 in. Describes and illustrates advantages and applications of double-strand chain type couplings with rating and size tables.

Flexible Lacquer Enamels—Roxalin Flexible Lacquer Co., Inc., Elizabeth, N. J. Five leaflets, 9x11 in. Describes a line of cellulose-type flexible lacquer enamels. Air drying and baking types applied by spraying, dipping or coating.

Fractional Horsepower V-Belts—B. F. Goodrich Co., Akron, Ohio. Catalog Section 2180, 27 pages, 8½x11 in. Describes line of "Longlife" V-Belts and pressed steel sheaves, tables give center distances, speed ratios and belt lengths. Directions are included for selection, installation, and maintenance.

Gas Engines—Worthington Pump & Machinery Corp., Harrison, N. J. Bulletin S-550-B4B, 8 pages, 8x10½ in. General description of design and construction with illustrations and line cuts of vertical four-cycle gas engines 15 to 105 hp. capacities.

Hoisting Equipment—Yale & Towne Mfg. Co., 4530 Tacony St., Philadelphia, Pa. Small catalog, 20 pages, 3 x 6 in. Contains data and illustrations covering a line of chain hoists, plain and geared type trolleys, and electric chain hoists.

Holophane Catalog—Holophane Company, Inc., 342 Madison Ave., New York, N. Y. Catalog 375-L, 44 pages, 8½x10¾ in. Contains an outline of the principles of control and distribution of light with a description of typical lighting units for flush, semi-exposed, and exposed installations, with tables of capacities, dimensions and weights. Reflectors in a number of styles and applications are illustrated with characteristic illumination curves.

Industrial Electric Heating Systems—Hynes Electric Heating Co., 240 Cherry St., Philadelphia, Pa. Bulletin No. 10. 16 pages, 8½x11 in. Illustrates and describes electric heating systems for oils and fluids in connection with circulating and industrial processes, also steam and hot water boilers.

Manual and Automatic Motor Controls—Ward Leonard Electric Co., Mount Vernon, N. Y. Bulletins and index pages, 8x10½ in. Consisting of revisions and several new additions to their general catalog. Additions cover new a.c. and d.c. manual and automatic motor controls, field rheostats, motor starting and disconnecting switches, and speed regulators.

Motoair, Combined Motor and Pump Unit—Steel City Electric Co., Pittsburgh, Pa. Folder 4 pages 8½x11 in. Announcing a line of pressure and vacuum pumps for use on automatic paper feeders and for removing cuttings.

Needle Bearings—Torrington Co., Torrington, Conn. Catalog, 8 pages, 8½x11 in. Lists specifications and tolerance of "B" Series (open-end) and "M" Series (closed-end), and also the rated radial load capacity in pounds. Contains suggestions for installing and lubricating needle bearings.

Parallel Shaft Speed Reducers—Falk Corp., Milwaukee, Wis. Bulletin, 1100, 56 pages, 8½x11 in. Describes design, arrangements of gears, shafts and bearings. Construction specifications are outlined with ratings and efficiencies. Engineering data is given in condensed form. Dimensional cuts with tables are shown in 14 pages. Material is well supplemented with illustrations.

Phototube Pyrometers—C. J. Tagliabue Mfg. Co., Park & Nostrand Aves., Brooklyn, N. Y. Catalog No. 1101B, 16 pages, 8½x11 in. Describes the features of indicating, recording and controlling pyrometers which utilize a beam or light, a mirror galvanometer and a photo-tube. Contains illustrations and cuts of applications, exterior and interior views of standard models.

Preset-Speed Controllers—General Electric Co., Schenectady, N. Y. Folder GEA-962C, 6 pages, 8x10½ in. Explains features, advantages and construction of preset-speed controllers for wound-rotor motor drives especially as applied to printing machinery.

Right Angle Speed Reducers—Falk Corp., Milwaukee, Wis. Bulletin 2100, 60 pages, 8½x11 in. Describes design, arrangements of gears and bearings in both horizontal and vertical types. Interior views and line cuts are used to supplement text. Engineering data with tables of ratings, dimensions, and bed plate styles are presented to aid in making appropriate selections. Contains photographs of installations.

Screws, Bolts, Nuts and Allied Products—Elco Tool & Screw Corp., 1800 Broadway, Rockford, Ill. Catalog No. 36, 64 pages, 4¾x7¾ in. Arranged for easy reference, it contains information, data tables and illustrations of screws, bolts, nuts and finishes.

BOOKS AND BULLETINS

Theory of Lubrication

Mayo D. Hersey. 152 pages, 6x9 in. 24 illustrations, 8 tables. Brown clothboard cover, published by John Wiley & Sons, Inc., 440 Fourth Ave., New York, N. Y. Price $2.50.

The volume is based upon a series of lectures dealing with the mechanics of lubrication, and is intended to present the scientific principles underlying modern lubrication. It is addressed to physicists, engineers, investigators, and teachers.

Following a chronological outline of the developments of the laws of lubrication, the author applies Newton's law and definition of viscosity to Petroff's equation and Poiseuille's law, and establishes viscosity-temperature, viscosity-pressure relations, and expressions for frictional resistance of films. A thorough exposition is made regarding the elementary mechanical action taking place in the film as an aid in understanding the rather complicated mathematical and experimental results in the discussions of the hydrodynamic and dimensional theories with their practical applications. Analytical and graphical solutions are presented for determining the permanent running temperature of bearings, and temperature distribution in the metal and in the film. The subject of oiliness is also outlined, with definitions of terms and tests.

Engineering Alloys
Names, Properties and Uses

Norman E. Woldman, Ph.D., and *Albert J. Dornblatt, Ch.E.* 600 pages, 6¼x9¼ in. Red cloth binding. Published by the American Society for Metals, 7016 Euclid Ave., Cleveland, Ohio. Price $10.

Encyclopedia of 8,200 proprietary commercial and technical alloys manufactured in the United States and abroad. Aimed to present as large an amount of reliable and up-to-date information as consistent with convenience and space available. The information was obtained by direct correspondence with the alloy manufacturers, and supplemented by data obtained from commercial literature and technical publications.

The publication is made up of an alphabetical list of trade names of alloys with assigned serial numbers for locating data; a table arranged numerically by serial numbers giving keys for identifying manufacturers and source of information, also composition, process treatments, and physical properties; index of uses; a manufacturers' classification showing the alloys they make; a bibliography of references; with appendices covering classifications of corrosion-resistant and heat-resistant alloys, metallurgical terms used in heat-treating, physical and magnetic testing, and useful tables.

Handbook of Engineering Fundamentals

Ovid W. Eshbach. About 1,000 pages, 5½x8½ in., numerous illustrations and tables. Semi-flexible red clothboard covers. Published by John Wiley & Sons, Inc., 440 Fourth Ave., New York, N. Y. Price $5.

This is Volume I of the Wiley Engineering Handbook Series. Prepared by a staff of specialists under the editorship of Ovid W. Eshbach, this handbook has been written for the purpose of embodying in a single volume those fundamental laws and theories of science that are basic to engineering practice. With the exception of the technics of surveying and drawing, there is included the fundamental technology common to nearly all engineering curricula. The editor has succeeded admirably in fulfilling the purposes as set forth in his preface.

Only section I, consisting of 153 pages of mathematical and physical tables, bears any similarity to other engineering handbooks. Thus, Section II, which is devoted to mathematics is not a compilation of formulas and procedures, but can be better described as a highly condensed book on mathematics. Terse explanations are given throughout and numerous examples are used to illustrate the mathematical operations set forth. Similarly, Section III on physical units and standards introduces the subject with fundamental definitions and then explains the various dimension systems including mechanics, heat, electromagnetism, the c.g.s. unit systems and others. In each instance there is a brief but complete explanation given, including historical matter where such is pertinent to the subject.

As an example of the easy-reading style used by the editor, a paragraph headed "Standard Temperatures," reads, "Certain thermal states or temperatures may be reproduced and recognized by the fact that definite physical phenomena occur at these temperatures. Such thermal states are called 'fixed points,' and they may, quite apart from any temperature scale, be specified by the physical phenomena characteristic of those temperatures. Two fundamental fixed points are the ice point and the steam point." Following this, he defines the ice point and the steam point.

Other sections cover theoretical mechanics, mechanics of materials, mechanics of fluid, engineering thermodynamics electricity magnetism, radiation and light, acoustics and meteorology, chemistry, metallic materials, non-metallic materials and a brief section on contract, covering the definitions of the legal requirements and giving the proper procedure in drawing up contracts. Included is a list of 44 articles of the general conditions that should be covered in every contract, with an explanation of each one. In reading this section one is struck by the absence of Latin phrases, cumbersome sentences and clumsy exposition, so characteristic of legal books and documents.

This book could well be used, in spite of its brevity, as a college textbook, and engineers will find it invaluable, not only as a reference book, but also for the purpose of quickly reviewing engineering fundamentals about which they have grown hazy.

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Perspective and Optical Illusions of Depth

Theodore M. Edison, 44 pages, 6x9 in. Paper covers. Published by Calibron Products, Inc., West Orange, N. J. Price 50 cents for first copy, 30 cents per additional copies.

A convenient reference manual for the professional draftsman who is interested in perspective delineation and projection methods. Much of the subject matter should be of interest to the general reader. The technical portions require careful study to be thoroughly understood.

The first section deals with gauges of depth and optical illusions. Starting with an historical note, the "Perspective Methods" section comprises treatments of direct, vanishing and measuring point projection methods, and the use of various aids in drawing. Object-observer-picture plane relationships are described in the third section, also perspective rectification, curved objects, and aerial mapping. General notes, a comparison chart of methods, and a key to terms and symbols make up an appendix. The booklet is well illustrated with diagrams and illustrations.

Taper Roller Bearings

Department of Commerce — National Bureau of Standards, Washington, D. C. Simplified Practice Recommendation R67–36, 9 pages, 6x9¼ in., obtainable from Superintendent of Documents. Price, 5 cents.

This booklet supersedes Simplified Practice Recommendations R67–33 and contains a revision of the simplified list of stock sizes and varieties of taper roller bearings. Four tables are included giving the S.A.E. number and overall dimensions of series covering light, medium, heavy, and steep-angle taper roller bearings. Cooperation is urged to acquaint those interested with the advantages arising from industry's plan to eliminate excess varieties.

Diametral Pitch of Spur Gears

WILLIAM H. CLAPP
California Institute of Technology

IN DESIGNING gears wherein the diameters are not known or where a minimum diameter of gear is desired, most of the factors given in the Lewis equation are unknown. The most debatable factor is the allowable working stress which depends, among other factors, upon the material used, accuracy of tooth form and spacing and pitch velocity of the gear. In any case it is largely a matter of engineering judgment.

For any given horsepower to be transmitted by the gear at a given r.p.m., the torque in inch-pounds can readily be calculated. With the allowable unit working stress assumed, the ratio of stress to torque can be determined. For a given number of teeth and given ratio of stress to torque, the chart gives the smallest allowable diametral pitch.

ILLUSTRATIVE PROBLEM

An automobile engine develops 60 hp. at 1,200 r.p.m. and 120 hp. at 3,200 r.p.m. The clutch gear has 25 teeth of 20 deg. involute stub form and it meshes constantly with a 39 tooth mate. The gears are to be made of a 0.45 carbon alloy steel—hardened and tempered to give an ultimate tensile strength of 240,000 lb. per sq. in. Determine the probable pitch of these gears for use in calculating strength and wear resistance by the accepted A.G.M.A. rules of procedure.

In the problem, as stated above, only one of the five quantities used in the Lewis equation is known, namely, the form factor Y. If the designer is an expert or a good guesser he may select the proper diametral pitch. A surer and quicker way is to guess the probable velocity reduction factor $k = C/C + V$, where C is some constant which depends upon the pitch velocity and also upon the accuracy of the gears. The various curves shown in Fig. 1 give this relationship and are well known to designers.

In this problem k might be taken as $\frac{1}{2}$ at 1,200 r.p.m. and perhaps as $\frac{1}{3}$ at 3,200 r.p.m. The actual pitch velocities are not known but these values cannot be far off.

For the 1,200 r.p.m. speed we have:

$$\text{Torque} = \frac{63{,}024 \times \text{h.p.}}{\text{r.p.m.}} = \frac{63{,}024 \times 60}{1{,}200} = 3{,}150 \text{ lb.-in.}$$

Stalling stress, $S_o = \frac{1}{3}\ (240{,}000) = 80{,}000$ lb. per sq. in.

$S = \frac{1}{2}\ (80{,}000) = 40{,}000$ lb. per sq. in.

$$\text{Ratio of } \frac{\text{stress}}{\text{torque}} = \frac{40{,}000}{3{,}150} = 12.7$$

Using this value for the ordinate and 25 as abscissa, the intersection is found midway between 8 and 9 diametral pitch for 20 deg. stub teeth.

If a value of $k = \frac{1}{3}$ and 3,200 r.p.m. were used,

$$\text{Torque} = \frac{63{,}024 \times 120}{3{,}200} = 2{,}365 \text{ lb.-in.}$$

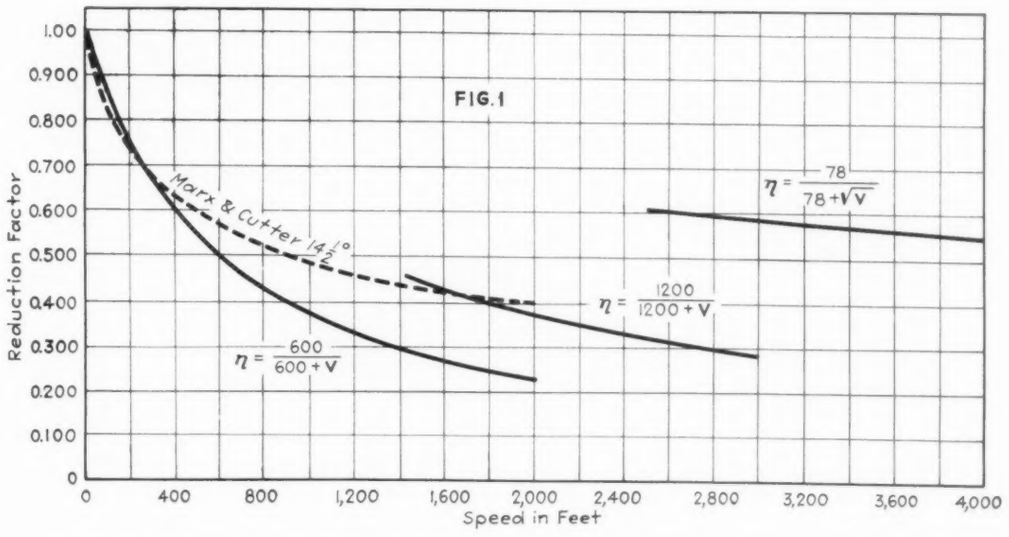
$S = \frac{1}{3}\ (80{,}000) = 26{,}667$ lb. per sq. in.

$$\text{Ratio of } \frac{\text{stress}}{\text{torque}} = \frac{26{,}667}{2{,}365} = 11.3$$

which again calls for an 8 d.p. stub gear.

The chart has been constructed for a face width of 10/DP, or 1.25 in. in this case. It is probable that any adjustments that may be required because of calculations for strength and wear can be made to the face width rather than to the diametral pitch.

The chart has the merit of showing at a glance the field which a gear of a given pitch might be expected to cover.



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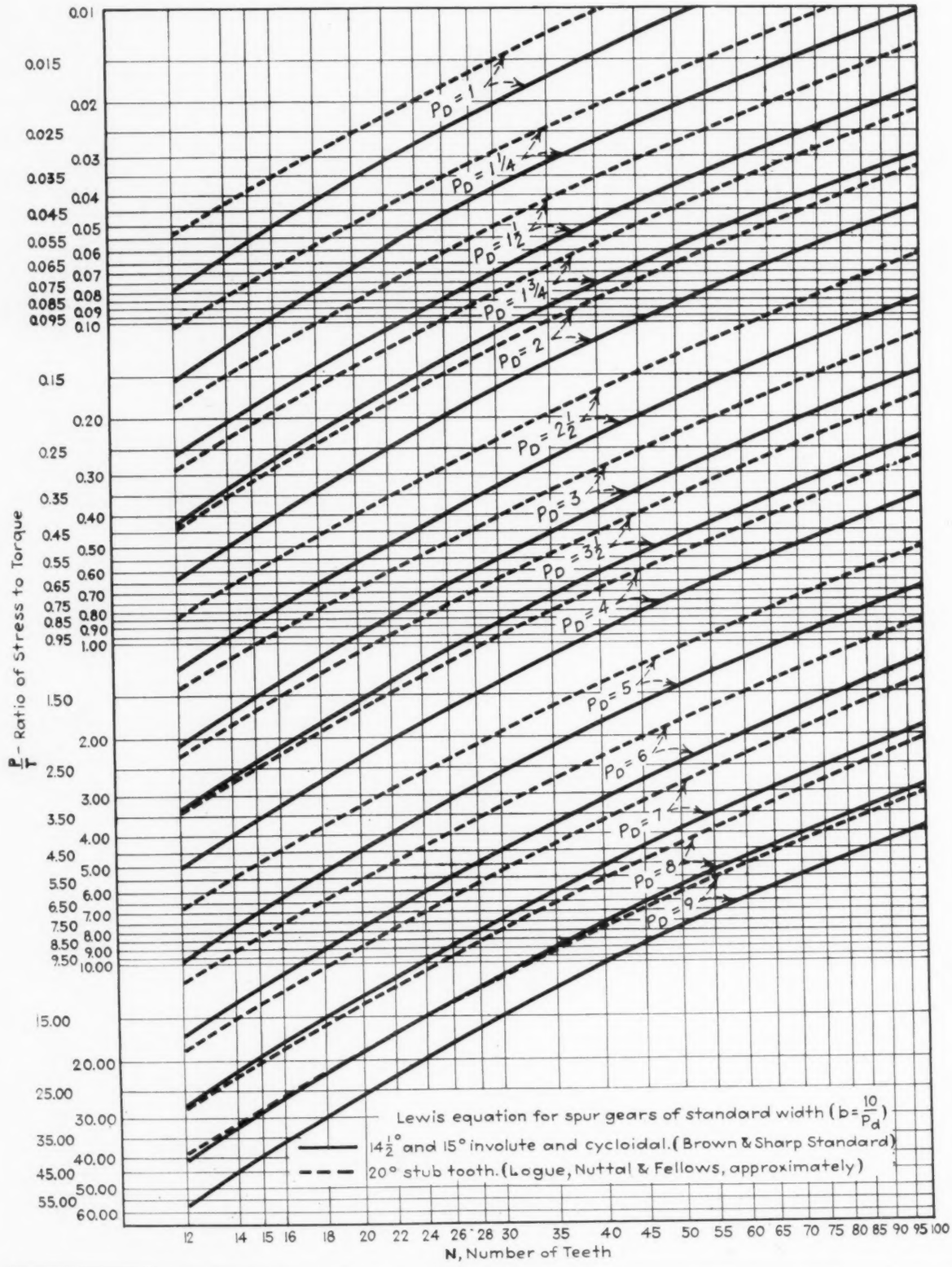

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